ALISO CREEK 13225 DIRECTIVE

REVISED MONITORING PROGRAM DESIGN – INTEGRATION WITH NPDES PROGRAM

Submitted to:
San Diego Regional Water Quality Control Board

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Prepared By:

County of Orange
Orange County Flood Control District
City of Aliso Viejo
City of Laguna Beach
City of Laguna Hills
City of Laguna Niguel
City of Laguna Woods
City of Lake Forest
City of Mission Viejo

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1.0 INTRODUCTION AND OVERVIEW

This document describes a revised monitoring program for bacteria in the Aliso Creek watershed that integrates monitoring previously required under the California Water Code Section 13225 Directive (from the San Diego Regional Water Quality Control Board dated March 2, 2001) into the ongoing NPDES permit monitoring program conducted by the County of Orange (County), the Orange County Flood Control District, and the cities of Aliso Viejo, Laguna Beach, Laguna Hills, Laguna Niguel, Laguna Woods, Lake Forest, and Mission Viejo (Permittees). The revised and refocused monitoring program will thus represent a special focus within the larger National Pollutant Discharge Elimination System (NPDES) water quality monitoring program being conducted throughout the southern portion of the County. This in turn will achieve efficiencies of scale by integrating the Aliso Creek watershed monitoring efforts into the current NPDES monitoring activities in this watershed.

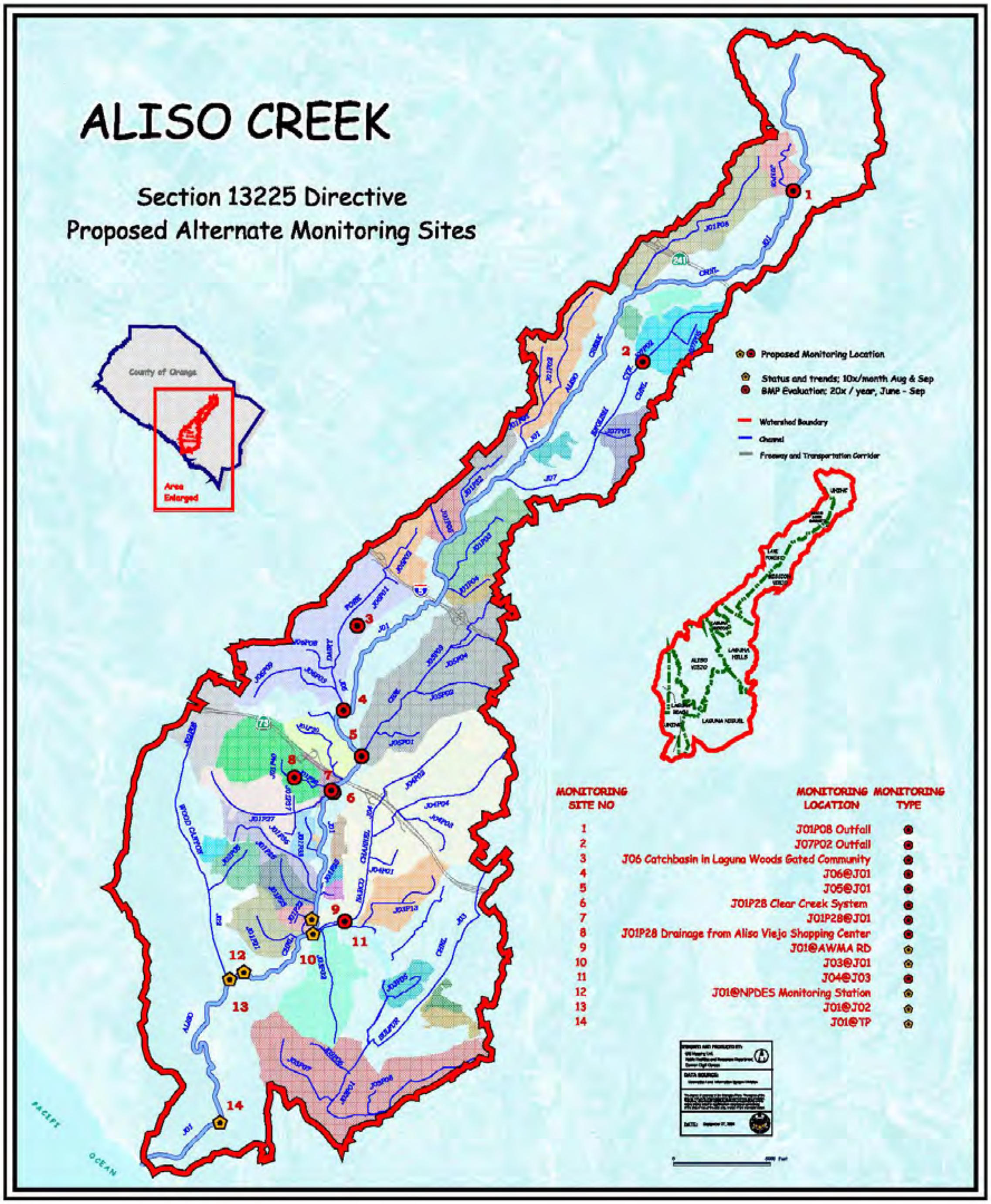
The proposed revisions, based on several years of monitoring data, build on improved knowledge about overall patterns of bacteria in the watershed as well as more localized responses to specific Best Management Practices (BMPs). The proposed program (**Figure 1**) focuses monitoring efforts on a group of status and trends sites near the bottom of the watershed and a second set of BMP evaluation sites at high-priority drains throughout the watershed. Monitoring will occur at a higher frequency than at present, but only during the two-month period in late summer when bacteria levels are highest. Analyses of the available monitoring data show that this design will sufficiently track compliance with REC1 standards in the area of highest recreational use in the lower watershed and document the effectiveness of BMPs implemented at the high-priority drains.

The revised program presented below contains important adaptive components that will ensure the monitoring program maintains its focus on key management questions, responds appropriately to monitoring findings, initiates new activities only when they are supported by the monitoring data, and reduces monitoring effort when it no longer provides useful information.

The prioritization process that resulted in selection of the high-priority drains in the Aliso Creek watershed is consistent with the basic intent of the prioritization process being used in both the San Diego and Santa Ana Regions to select dry weather reconnaissance sites for follow-up source identification efforts. In addition, the use of specific triggers that would lead to changes in the monitoring design and/or additional studies is a fundamental feature of the current NPDES monitoring programs in both Regional Board areas of Orange County.

Figure 1. Location of the revised monitoring locations

Includes five status and trends sites and nine BMP evaluation sites.



2.0 FUTURE MONITORING OBJECTIVES

The revised program design will focus on bacterial contamination and will:

- Document trends in water quality at high-priority locations
- Evaluate BMPs implemented to improve water quality
- Support source identification efforts.

These program objectives provide the underpinning for the specific monitoring questions presented in the following sections.

Monitoring at the revised sites and times will continue to rely on the indicators currently used, specifically:

- Total and fecal coliforms (all sampled sites and times)
- Enterococcus (all sampled sites and times)
- Total chlorine (drains only, once / month)
- pH (drains only, once / month)
- Temperature (drain and downstream station, all sampled times)
- Estimated flow (drains, all times).

In addition, the sampling design will retain the structure of monitoring:

- The pipe discharge at each site
- Ambient bacteria concentrations 25 feet upstream of the discharge point
- Ambient bacteria 25 feet downstream of the discharge point.

This will maintain consistency with past data in the watershed and agrees with the recommendations developed by the Stormwater Monitoring Coalition's (SMC) model stormwater monitoring program project. Monitoring the suite of three bacterial indicators along with flow also conforms to the recommendations of the SMC model stormwater monitoring reports, available on the Southern California Coastal Waters Research Project (SCCWRP) website.

3.0 PROPOSED REVISIONS

The following subsections describe proposed revisions to status and trends monitoring, BMP evaluation monitoring, and source identification efforts. **Figure 1** summarizes all station locations and sampling frequencies for both status and trends and BMP evaluation portions of the program (see **Appendix A** for additional detail).

3.1 Status and Trends Monitoring

Status and trends monitoring focuses on answering two questions:

1. Are conditions in receiving waters protective of beneficial uses? (status)
2. Are conditions in receiving waters getting better or worse over time? (trends)

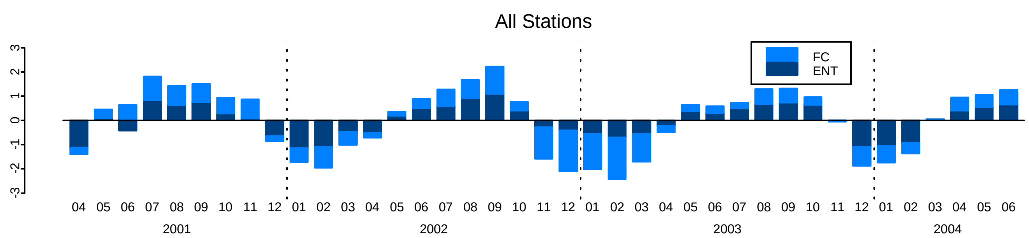
Status and trends monitoring will take place at five core stations in the lower portion of the watershed (**Figure 1**), which past studies indicate is the area of highest recreation use and related concern about potential human health impacts (see **Appendix A.1** for further background and justification). Despite some variability among them, the stations as a group provide a picture of conditions in the lower portion of the Creek.

These five stations will be monitored during August and September, at a frequency of 10 samples per month. This period represents the most conservative sampling period because it:

- Captures the annual peak of bacteria levels in the watershed (**Figure 2**)
- Is the time of year that body contact recreation is most likely.

Figure 2. Overall seasonal pattern of bacteria levels in the Aliso Creek watershed, summarized over all stations.

Data represent monthly means of levels in discharges from all drains over the 2001 – 2004 period. The darker portion of each vertical bar indicates Enterococcus and the lighter blue portion fecal coliform.



The monitoring frequency was selected with the goal of detecting an 80% drop in fecal coliform levels over a ten-year period. This sampling frequency is based on analyses of the ability to detect change for various levels of sampling effort (**Appendix B.1**). These analyses show this sampling frequency has the ability to both assess compliance with the REC1 objective in the most critical period of the year as well as to track trends over time.

Once the REC1 objective has been met in the lower sections of the Creek, then further monitoring effort could be focused on a second tier of sites along the higher sections of the Creek with a lower level of human health risk. Alternatively, if additional monitoring data show that conditions in the lower Creek can be adequately described by a smaller number of stations, then some of this monitoring effort could be reallocated to a second-tier site elsewhere in the watershed. (See **Section 5.0** and **Appendix C** for additional detail on the decision framework.)

Finally, while this program does not explicitly attempt to connect with the developing bacteria TMDL for the San Diego Region, one of the long-term status and trends sites does correspond with the "critical point" at the bottom of the watershed defined in the proposed TMDL.

3.2 BMP Evaluation

BMP evaluation monitoring focuses on answering three questions:

1. Have bacteria loads from the high-priority drains decreased?
2. Are BMPs having their intended effects on concentrations in and/or loads from the drains?
3. Have impacts from high-priority drains on the receiving waters decreased?

3.2.1 Sampling frequency

BMP evaluation monitoring will take place at nine sites in the six high-priority drainage areas in the watershed (**Figure 1**). These are the areas where the most concentrated efforts to implement BMPs have occurred and which are therefore the highest priority for evaluation monitoring. Additional background on site selection can be found in **Appendix A.2**.

The BMP evaluation sites will be monitored during the June – September period, with a total of 20 samples collected at each site each year during this period. Analyses of historical data (see **Appendix B.2**) suggest that, with minor exceptions, this would be adequate to detect an average 50% reduction in loads and an average 30% reduction in impact on downstream receiving water at each site over a ten-year period.

3.2.2 BMP effectiveness

Analyses of historical data from the watershed (see **Appendix B.3** for more detail) also show that, with the data available now, changes in water quality at some drains are detectable, although the association with BMP implementation is not always clear.

Figure 3, for example, shows the two drains with the largest observed decrease in loads (based on dry season values).

- In the J01P25 drainage, the City of Laguna Niguel has been implementing its Local Implementation Plan (LIP) (also sometimes referred to in this document as the JURMP Action Plan) and has also installed a CDS unit to remove trash and sediment.
- In the J01P28 drainage, the City of Aliso Viejo has been implementing its LIP, fixed a significant pipe leak in early 2002, and then in mid-2002 began a greater intensity of inspection, education, and BMP implementation. A Clear Creek treatment system was installed at the J01P28 outfall and began operation in mid-2003.

Conversely, **Figure 4** shows two drains with increased loads, neither of which was targeted for more intense effort above the LIP.

- In the J01P06 drainage a manufacturing plant and a new nursery may have increased runoff. **Figure 4** shows that, since mid-2003, flow (CFS) in J01P06 has been consistently above the system-wide mean.
- In the J06 drainage, there is no readily available explanation for the pattern seen.

Figure 5 summarizes the cumulative monitoring data to show there is not always a consistent relationship between the degree of visible improvement in discharge loads and the relative intensity of BMP implementation in each drain's drainage area.

The monitored drains in the watershed fall into three categories in terms of trends in discharge loads (**Figure 5**; see **Appendix B.3** for more detail):

1. Those with visible improvement in loading(11 drains)
2. Those with no apparent loading trends (18 drains)
3. Those that are visibly worse in loading(7 drains).

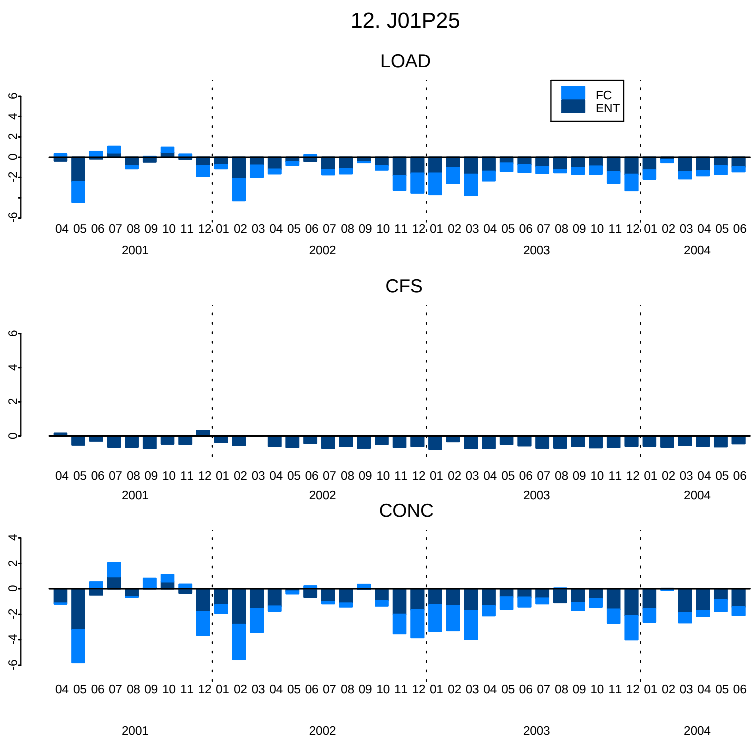
The lack of a consistent relationship between the intensity of BMP implementation in a drainage area and the size or direction of trends in loads from the discharge suggests that additional monitoring will be required to:

- Validate trends in category #1 drains and determine their relationship to BMPs
- Resolve trends in category #2 drains
- Determine if improvements appear in category #3 drains with more intensive BMP implementation.

Data from the BMP evaluation sites will also be compared to the results of the status and trends monitoring in the lower sections of Aliso Creek. This will help to assess whether a reduction in loads at the high-priority drains is associated with improving conditions in the lower Creek. **Table 1** presents a framework for conducting this comparison. As questions about BMP effectiveness at the high-priority drains are resolved over time, monitoring effort would be shifted to the next level of priority drains. See **Section 5.0** and **Appendix C** for additional detail on the decision framework.

Figure 3. Two drains showing largest decrease in discharge loads. All parameters calculated as deviations (either plus or minus) from long-term system mean. The dark portion of each vertical bar indicates Enterococcus and the blue portion fecal coliform. "Load" is bacterial load in the pipe discharge; "CFS" the measure of flow (cubic feet/second) in the discharge; "CONC" the concentration in the discharge.

Basic JURMP Action Plan; CDS unit



Basic JURMP Action Plan; fixed pipe leak early 2002; began major focus on inspection, education, and BMP implementation mid-2002; Clear Creek treatment system operational mid-2003

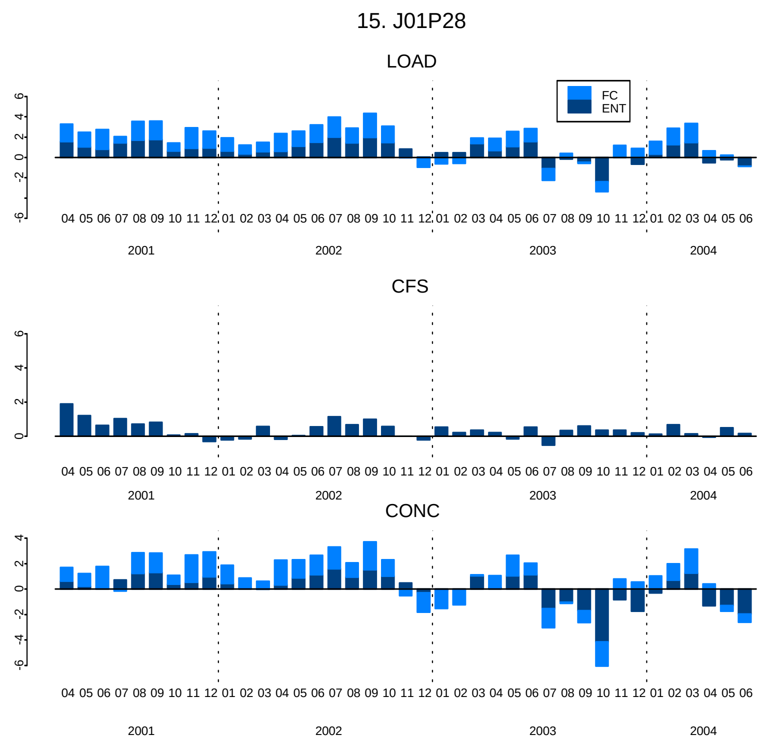
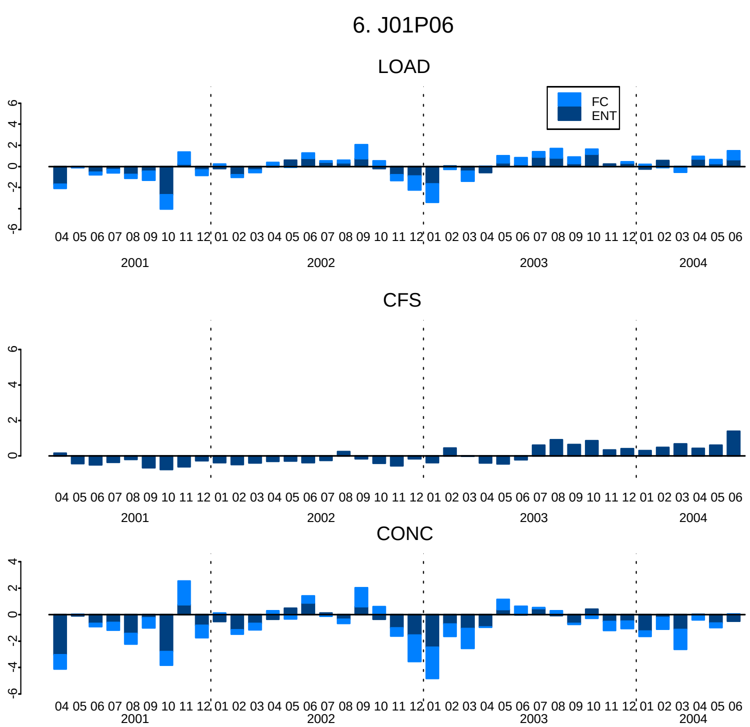


Figure 4. The two drains showing the largest increase in discharge loads. All parameters as in Figure 3.

Basic JURMP Action Plan



Basic JURMP Action Plan

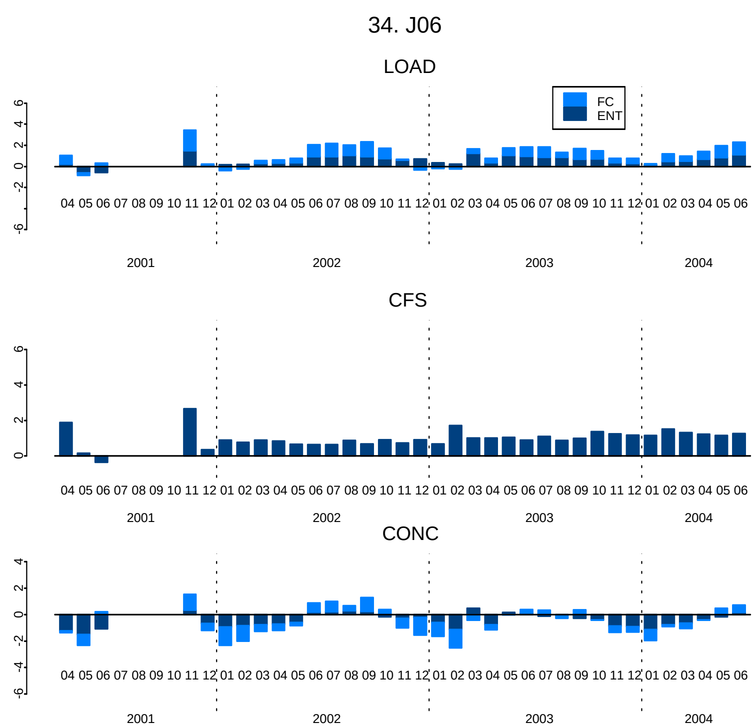


Figure 5. Map legend indicates four categories of BMP implementation and three categories of trend in loads. See Table B-2 for more detail on BMP efforts. Unshaded drainage areas did not contain discharge pipes meeting program criteria and were not monitored.

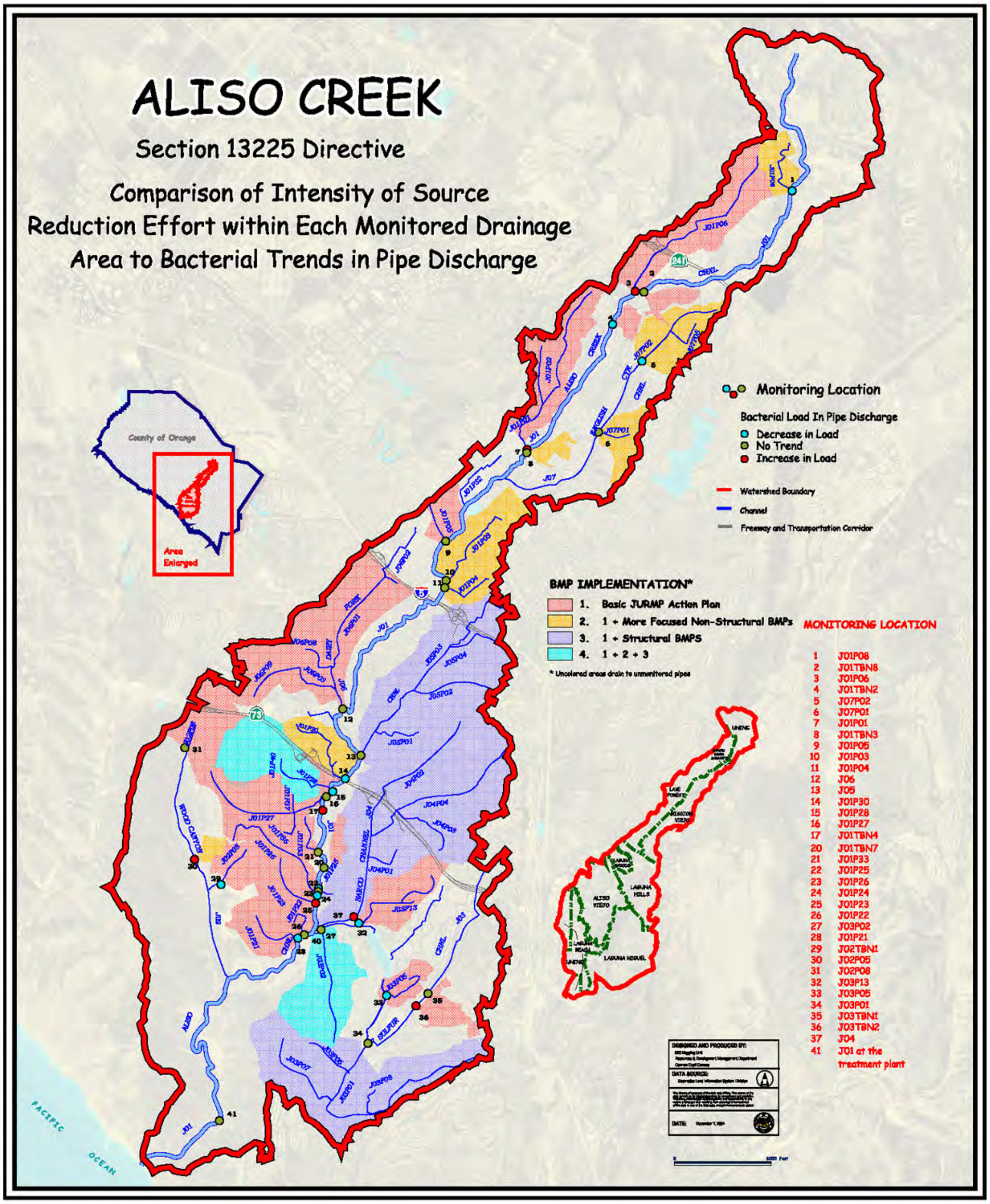


Table 1. Potential monitoring outcomes and their implications

"Conceptual model" refers to the set of mechanistic assumptions about how BMPs will affect bacterial levels and loads.

Trend at S&T stations	BMPs work and are widely implemented	BMPs work but are not widely implemented	BMPs don't work
Trend downward	are seeing the effects of BMPs	Are seeing the effects of BMPs; confirm with loads modeling other factors are involved; develop new conceptual model	other factors are involved; develop new conceptual model
No trend (variable)	other sources likely; develop new conceptual model	BMPs not widely enough implemented to reduce the problem	problem remains as originally envisioned
Trend upward	other sources likely; develop new conceptual model	other sources likely; develop new conceptual model	other sources likely; develop new conceptual model

3.3 Source Identification

The revised bacteria monitoring program will also support ongoing source reduction efforts in the watershed. One aspect of such efforts is the Permittees' NPDES dry weather reconnaissance monitoring program, which has several random and targeted sites in the Aliso Creek watershed (**Table 2**). As the targeted sites are resolved and replaced with new sites over the course of the Third-Term Permit, this rotating set of sites will provide coverage of the MS4 system and trigger upstream source identification efforts at those sites with pollutant levels that are substantially above the regional background.

Table 2. Random and Targeted Dry Weather Sites in the Aliso Creek Watershed

City	Random sites	Targeted sites
Aliso Viejo	J01P27 J01P28	J01P26 J01P33 J02P05
Laguna Beach	None	No high-priority sites in the Aliso Creek watershed
Laguna Hills		J04P04
Laguna Niguel	J03P01	J03TBN J04@J03
Laguna Woods	Moulton & Calle Cortez J01@Alisos Blvd.	J06P01 inside Leisure World gate
Lake Forest	J01P01 J01P05	J01P08
Mission Viejo	J07P02	J01P03

Additional targeted source identification studies may be called for in response to findings that bacteria levels in the high-priority drains and/or in the Creek itself are either increasing or not decreasing as expected (see **Section 5.0**). Such adaptive source identification efforts will have clearly defined terminology, methods, and endpoints, in line with the SMC's recommendations in its model stormwater monitoring program description.

4.0 SPECIAL STUDIES

There are a number of special studies that could be carried out to:

- Reassess monitoring results
- Evaluate BMP effectiveness
- Investigate bacterial dieoff / proliferation processes in the drains themselves
- Evaluate and then apply improved microbial source tracking (MST) methods to better identify sources of pollution.

The structure and timing of these and other potential special studies will largely be based on monitoring results, as well as on the progress and results of outside studies.

Monitoring results will be reassessed when they do not correspond to past patterns and/or to expectations of how bacteria levels should change in response to BMPs.

Targeted studies of BMP effectiveness in the Aliso Creek watershed should be conducted when monitoring data are not sufficient to confirm their effectiveness and/or when it is determined that available data from studies carried out elsewhere are not applicable to the Aliso Creek watershed.

Bacterial dieoff/proliferation processes should be investigated when SCCWRP and the SMC, both of which include Regional Board representatives, agree that there is enough evidence to warrant a scientific study. Any such study should be undertaken in progressive stages (e.g., literature review, pilot study, field assessment).

Microbial source tracking methods should be field tested in the Aliso Creek watershed only when SCCWRP and the SMC agree that the available methods have been developed to the point they are likely to provide definitive and quantitative information about sources of bacterial contamination in the watershed.

5.0 DECISION POINTS

The revised program includes a decision framework that will guide the interpretation of monitoring information and its application to decision making (**Figure 6**). Such clearly defined decision points will ensure that:

- Monitoring results are used in management decisions in a timely way
- The monitoring design is adjusted as needed to incorporate improved scientific knowledge and to remain responsive to management concerns
- Monitoring does not continue past the point at which it provides relevant and useful information.

Bacteria monitoring in the Aliso Creek watershed occurs in a wider context that also includes BMP implementation, active source identification efforts, and the development of improved microbial source tracking methods. Thus, there are a number of triggers that could suggest changes to the monitoring plan, adjustments to BMP design and implementation, and/or revisions to management policies about bacteria levels in Aliso Creek.

Figure 6 outlines an overall decision framework that combines monitoring of both status and trends and BMP effectiveness with the results of source identification efforts to provide specific guidance for the interpretation and application of monitoring results. The triggers and endpoints for each of the actions in the decision framework are designed to be as explicit as possible. If improvements to knowledge stemming from monitoring results and/or research alter the specifics any trigger or endpoint, then the trigger or endpoint will be redefined.

5.1 Objective for the Lower Creek

This framework reflects the management priority placed on human health issues in the Creek, that is, the risk of illness due to body contact recreation "where the ingestion of water is reasonably possible." In accord with the approach adopted by the Beach Water Quality Work Group and the SMC's model stormwater monitoring project, the revised Aliso Creek bacteria monitoring program focuses monitoring for human health initially in the lower sections of Aliso Creek where surveys of recreational activity have shown higher-risk use to be concentrated. Thus, the immediate objective, or endpoint, identified for this status and trends monitoring at the five stations in the lower Creek is the Basin Plan REC1 objective. Once the REC1 objective has been met in the lower Creek, the status and trends monitoring in the lower Creek can be reevaluated and converted to a core, long-term health monitoring program. In addition, once the REC1 objective is met in the lower Creek, the upstream BMP evaluation monitoring effort at the six high-priority drains can be reallocated to a second tier of sites along the Creek with a lower level of human health risk.

5.2 Objective for the High-Priority Drains

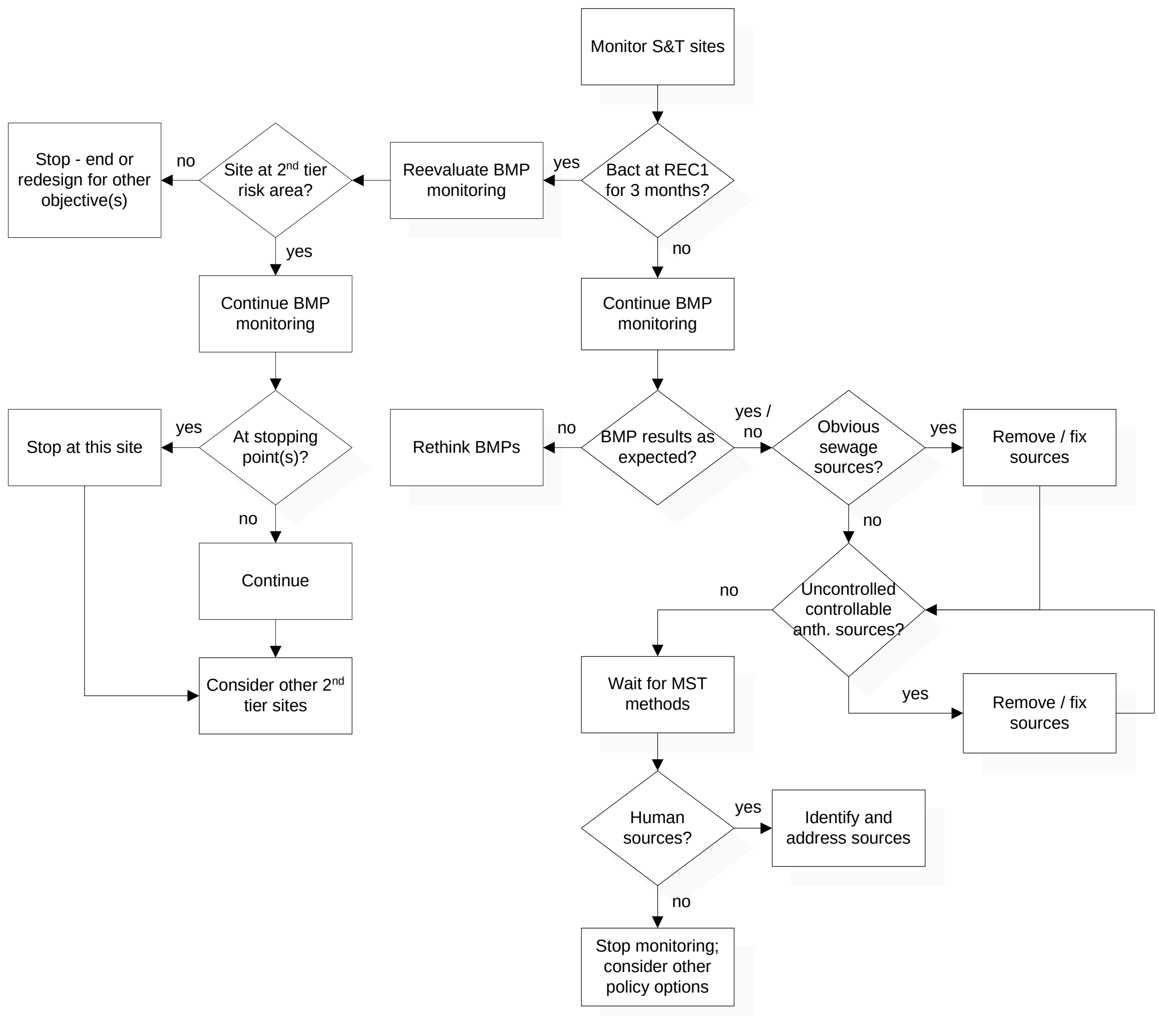
Efforts to improve water quality in order to meet the REC1 objective in the lower sections of Aliso Creek are concentrated on the specific upstream discharges to the Creek, where a range of source identification, enforcement, and pollution prevention activities are planned and/or underway. Monitoring of the effectiveness of these BMP efforts is currently concentrated on stations associated with the six high-priority drains throughout the Aliso Creek watershed. The immediate objective for this monitoring is to assess whether these activities have contributed to an improvement of conditions in the lower sections of the Creek. A parallel objective is to provide site-specific feedback about whether these efforts are working as expected. Explicit endpoints for this BMP evaluation monitoring are associated with the completion of a series of source identification efforts:

- Identify obvious sources of human sewage
- Identify uncontrolled controllable anthropogenic sources
- Apply microbial source tracking methods when available
- Address additional controllable anthropogenic sources identified by microbial source tracking.

These source identification efforts will follow explicit protocols being reviewed and organized by the SMC's model stormwater monitoring program. Once remaining sources have been determined to be uncontrollable and/or non-urban in nature, then the monitoring described here will have provided as much useful information as it can. At that point, if conditions in high-risk areas of the Creek have still not met the REC1 objective, then whether to implement structural BMPs and other treatment options would be a policy decision based on a number of factors, including the nature of the sources, the amount of recreation actually occurring in different portions of the creek, BMP effectiveness, and the cost and feasibility of implementation.

Figure 6. Decision Framework for Aliso Creek Watershed Bacteria Monitoring

(S&T refers to Status and Trends.)



6.0 SUMMARY

The revised bacteria monitoring program for the Aliso Creek watershed focuses on three core objectives:

- Documenting trends in water quality
- Evaluating BMPs implemented to improve water quality
- Supporting source identification efforts.

The new program takes advantage of knowledge gained during the past three years of monitoring to reduce the number of sampling locations, identify a core set of status and trends monitoring stations that will provide information on the condition of the Creek as a whole, and make changes to sampling frequency. In addition, the revised program targets monitoring at those locations in individual drainage areas where changes due to management efforts are most likely to occur. Finally, the dry weather reconnaissance component of the Permittees' NPDES monitoring program provides targeted support for source identification efforts across the watershed.

These monitoring and source identification efforts have also been placed in the overall context of a decision framework that identifies alternative actions and decisions in response to a range of monitoring findings. This decision framework reflects the adaptive nature of the monitoring program and its intent to respond appropriately to new information as it becomes available.

In addition to these monitoring efforts, certain special studies may provide opportunities to substantially improve the efficiency of monitoring, the utility of BMPS, and/or the ability to identify sources of pollution. As these studies are conducted, their results will be used to further refine the monitoring program and the cities' source identification and source reduction efforts.

APPENDIX A: JUSTIFICATION FOR MONITORING LOCATIONS

Table A-1 summarizes all station locations and monitoring frequencies for the revised program (note that there are a few minor exceptions to the general pattern of discharge, up-, and downstream sampling).

A.1 Status and Trends Station Locations

The proposed revisions to the locations of status and trends monitoring stations are intended to focus effort on the areas of highest recreational use and attendant concern about potential human health impacts. This approach is in accord with that recently adopted by the Beach Water Quality Work Group (made up of representatives from county health departments, the State Water Resources Control Board, SCCWRP, and Heal the Bay), as well as by the SMC's model stormwater monitoring program project. Past surveys of recreational use in the Aliso Creek watershed (summarized in the program's 3rd quarterly report; Figure 2.20: Recreational Sites and Activities, Table 2.7: Activities Within Recreation Facilities in Aliso Creek Watershed) show that the majority of recreational use "where the ingestion of water is reasonably possible" (Basin Plan definition of REC1 beneficial use) occurs in the lower part of the Creek. (This is the most current information available that is not purely anecdotal.) This is an important criterion because ingestion has been demonstrated as the principle route by which contaminated waters cause illness.

Thus, the status and trends monitoring stations listed in **Table A-1** include five core monitoring stations along the lower sections of Aliso Creek. The available data show that the stations in the lower creek are dissimilar, with a progression of increasing indicator values in the downstream direction. The behavior of individual stations is so variable that it would be risky to extrapolate from one station to the entire lower Creek. Thus, the stations, as a group, provide a picture of conditions in the lower portion of the Creek. More detailed site location information is presented in **Table A-1**.

A.2 BMP Evaluation Station Locations

BMP evaluations will be based on data from stations associated with the six high-priority drains listed in **Table A-1**. A review of the structure of the drainage system in each city, along with the geographic distribution of their source reduction and/or pollution prevention efforts, led to the identification of two additional monitoring sites in Aliso Viejo (drainage to J01P28) and one in Laguna Woods (drainage to J06). These sites are intended to improve the monitoring program's ability to distinguish the effectiveness of source reduction efforts within those cities. In the remaining cities, source reduction efforts are distributed throughout the subwatershed and/or are concentrated in the lower portion of the subwatershed. In these cases, the monitoring site at the discharge point to Aliso Creek is adequate for assessing the overall results of BMPs in the subwatershed.

The BMP evaluation sites are intended to fulfill two purposes. The first is to document the relative effectiveness of source reduction efforts in the high-priority subwatersheds.

Given that similar source reduction efforts are being implemented throughout the Aliso Creek watershed, the second purpose is to produce information to help guide decision making about source reduction efforts at other locations. As questions about BMP effectiveness at the high-priority drains are resolved over time, monitoring effort would be shifted to the next level of priority drains.

In addition to existing source reduction efforts throughout each drainage area, additional structural BMPs are being implemented and/or planned, including the Munger Creek Filtration Basin on J01P01, a treatment wetland in the J01P04 drainage, a Clear Creek treatment system at the J01P28 outfall, and treatment wetlands in the J03P02 drainage. As these projects are implemented, additional monitoring sites to assess each project's effectiveness may be required, as are currently in place for the Clear Creek system.

Table A-1. Sampling sites in the revised monitoring program. Map ID refers to station numbers on Figure 1.

Type of site & Map ID	Drainage	City	Site location	Sampling location(s)	Frequency	Comments
Status and trends #9	Creek	Laguna Niguel	Creek at AWMA Rd. bridge	1 station in Creek	10 / mon Aug & Sep	Core trend monitoring station on the Creek
Status and trends #10	Creek	County	Sulphur Creek (J03) at Aliso Creek (J01)	Sulphur Creek 25' up / down	10 / mon Aug & Sep	Core trend monitoring station on the Creek
Status and trends #12	Creek	County	Aliso Creek (J01) in Aliso Wood Canyon Park	At NPDES mass emission station	10 / mon Aug & Sep	Core trend monitoring station on the Creek
Status and trends #13	Creek	County	Wood Canyon Channel (J02) at Aliso Creek (J01)	25' up / down	10 / mon Aug & Sep	Core trend monitoring station on the Creek Wood Canyon Channel discharge not readily accessible
Status and trends #14	Creek	County	Aliso Creek (J01) at SOCWA treatment plant	1 station in Creek	10 / mon Aug & Sep	Core trend monitoring station on the Creek
BMP evaluation #1	J01P08	Lake Forest	J01P08 outfall at Aliso Creek (J01)	Drain 25' up / down	20 total Jun – Sep	Drains a residential area. Outreach is distributed in the drainage area and includes informational letters and other public education. Advanced irrigation controls planned for 2005.
BMP evaluation #2	J07P02	Mission Viejo	J07P02 outfall at Aliso Creek (J01)	Drain 25' down	20 total Jun – Sep	No upstream location Evaluate effectiveness of follow-up intensive reconnaissance investigations. Evaluate effectiveness of performing inspections and follow-up enforcement of all high-priority commercial and industrial facilities.

Table A-1. (continued)

Type of site & Map ID	Drainage	City	Site location	Sampling location(s)	Frequency	Comments
BMP evaluation #3	J06	Laguna Woods	J06input Inside gated community	To be determined	20 total Jun – Sep	Monitor effectiveness of source reduction efforts inside community.
BMP evaluation #4	J06	Laguna Woods	J06 at Aliso Creek (J01)	Drain 25' up / down	20 total Jun – Sep	Conducting increased inspections and education, especially at construction sites.
BMP evaluation #5	J05	Laguna Hills	J05 outfall at Aliso Creek (J01)	Drain 25' up / down	20 total Jun – Sep	Drains a residential area and a 10 acre wetland near the bottom of the drainage area. Wetland is intended to improve water quality.
BMP evaluation #7	J01P28	Aliso Viejo	J01P28 at Aliso Creek (J01)	Drain 25' up / down	20 total Jun – Sep	High-priority drain
BMP evaluation #6	J01P28	Aliso Viejo	Clear Creek system	Basin, discharge	20 total Jun – Sep	Clear Creek system treating water in drain just before discharge to Creek
BMP evaluation #8	J01P28	Aliso Viejo	Shopping center at Aliso Creek Rd. and Enterprise	Discharge from shopping center	20 total Jun – Sep	Inspection, education, and enforcement efforts concentrated at shopping center in upper portion of drainage
BMP evaluation #11	J04	Laguna Niguel	J04 at J03, at Aliso Creek Rd.	Drain	20 total Jun – Sep	Drains equestrian/agricultural area in upper part of drainage (Laguna Hills) that has been fitted with catch basin filters to remove bacteria. Outreach to residents with horses and farm animals. Catch basin retrofits in commercial areas in lower part of drainage (Laguna Niguel).

APPENDIX B: ANALYSIS OF HISTORICAL DATA

The past three years of monitoring data in the Aliso Creek watershed were analyzed to:

- Select an appropriate sampling period within the year
- Select a sampling frequency adequate to detect expected trends
- Confirm that effects of BMPs are observable in the watershed.

B.1 Status and Trends Sampling Period and Frequency

The current sampling frequency is weekly throughout the year, which has resulted in greater understanding of patterns of variability in the Creek. The past monitoring data has been examined to determine whether this frequency should be adjusted. Such adjustments are intended to better optimize the monitoring program's ability to determine if indicator levels in receiving waters are meeting appropriate water quality objectives (Question 1 (Section 3.1): Are conditions in receiving waters protective of beneficial uses?), as well as to quantify the amount of change in indicator values over time (Question 2 (Section 3.1): Are conditions in receiving waters getting better or worse over time?). The proposed new sampling frequency is:

> 10 samples per month, collected in August and September at each of the five core status and trends monitoring stations.

This would provide the ability to assess compliance with the REC1 objective in the most critical period of the year, as well as to track trends over time, with the goal of detecting an 80% reduction in fecal coliform levels over a ten-year period. An 80% decrease would represent a drop from the highest levels currently observed to near the REC1 level. The following paragraphs provide the technical rationale for this recommendation. They describe how:

- Sampling frequencies are based on examination of the historical data and on statistical power analyses
- Historical data show that peak bacterial levels occur in late summer and early fall, corresponding to the period of greatest recreational use, suggesting that this is the best period for conducting comparisons to the REC1 standard
- The ideal months for tracking trends during the peak period, however, differ from site to site
- The needed frequency for assessing compliance with the REC1 standard is 5 samples per month (30-day period), while the preferred frequency for assessing trends in a reasonable time frame is 10 samples per month
- The sampling frequency that meets both needs is 10 samples per month, in August and September.

The revised monitoring frequency is based on an examination of patterns in the Aliso Creek bacterial monitoring datasets as well as on statistical power analyses on these data. Statistical power analysis is a standard tool in study design, in which estimates of variability in target indicators are used to determine the level of sampling effort needed to detect different amounts of change in those indicators. Power analyses will be repeated at intervals, as additional data accumulate, to confirm that sampling frequencies are adequate or to provide the basis for any needed midcourse corrections to the sampling design.

The REC1 standard (related to Question 1) for fecal coliforms is a geometric mean of 200/100 ml for five samples taken over a 30-day period. In addition, not more than 10% of the samples taken over this period can exceed 400/100ml. **Figures B-1** and **B-2** show that the downstream stations are above the REC1 standard most of the time by both criteria. Since this is the portion of the Creek where the incidence of human contact recreation is highest, these data provide the basis for targeting sampling at a key subset of months rather than throughout the entire year.

The highest fecal coliform counts consistently occur in the summer and fall, with the peak usually in the fall. Since these are the warmer months where human contact recreation in the Creek is most likely, it will be most beneficial to reduce the fecal coliform levels during this period and monitoring should accordingly also focus on this period. **Figures B-1** and **B-2** indicate that two thirty day sampling periods in the late summer / early fall period should be sufficient to determine whether the creek locations meet the REC 1 standard during the most relevant and critical part of the year. When levels drop closer to the standard, further power tests should be performed to determine if additional precision could be achieved with an increased number of samples per 30-day period.

The situation for tracking trends (Question 2) is different, however. Because the fecal coliform levels vary considerably among the months in lower Aliso Creek, it would statistically be most efficient to stratify the trend analyses by month, with separate trend analyses for each month. Lumping months that normally have highly divergent fecal coliform counts would increase the within-year variability and make it more difficult to detect trends over time. Power tests (Fryer and Nicholson, 1993) were performed to estimate the number of years and number of samples within a 30-day period that might be required to detect different percentages of decrease in fecal coliform counts (**Figure B-3**). Power tests were performed only at stations and for months for which more than one year was sampled because the power tests require an estimate of between-year variability.

Figure B-3, with plots for each station organized in order of increasing geomean, shows that the ideal months to sample differ from station to station. For example, the highest power for a given sampling effort occurs in August for the SOCWA treatment plant site (**Figure B-3.d.**) but in June for the Aliso Wood Canyon Park Site (**Figure B-3.c.**).

Because it would be logistically inefficient to sample each station at a different time, some tradeoffs are always required in applying power analysis results to real-world situations. In this case, a sampling frequency of 10 samples per month, collected in August and September at each of the five stations would provide the ability to assess compliance with the REC1 objective in the most critical period of the year, as well as to track trends over time, with the goal of detecting an 80% reduction in fecal coliform levels over a ten-year period. An 80% decrease would represent a drop from the highest levels currently observed to near the REC1 level.

B.2 BMP Evaluation Sampling Frequency

As for the status and trends monitoring, statistical power analyses were used to determine an appropriate sampling frequency for the BMP evaluation stations and the revised monitoring frequency of 20 samples per year at each high-priority drain station, collected in the June – September period, is based on these analyses.

Figure B-4 shows that bacterial levels in the high-priority drains, as well as at the upstream and downstream stations associated with each, are typically highest in the June – September period and lower throughout the rest of the year. Power analyses therefore focused on this period in order to reduce the within-year variability. Power analyses were performed for two measures, the load from each drain (**Figure B-5**) and the impact of each drain (**Figure B-6**) measured as the difference between the downstream and upstream stations. It will not be feasible to track loads at station J06 (**Figure B-5**) nor to track impacts at station J01P08 (**Figure B-6**). With the exception of these parameters at these stations, however, the power analysis suggests that a sampling frequency of 20 samples, collected in the June – September period, would be adequate to detect an average 50% reduction in loads and an average 30% reduction in impact over a ten year period.

B.3 Analysis of BMP Effects

Our past experience with the inherent variability in bacteria levels (both in discharges and in receiving waters), along with the statistical power analysis results, show that it may well take many years to reliably detect substantial trends in measures of loads and impact at individual sites. We therefore investigated other, system-wide analysis approaches which proved able, in some instances, to describe the results of BMP implementation on a shorter time frame.

The first analysis approach is based on a method commonly used by oceanographers and climate scientists. It involves calculating the overall system-wide mean of key parameters (e.g., loads, flow) and then examining the deviations over time from the system mean at each site. This approach was informative in providing more insight into both the unique behavior of each site as well as responses to BMPs. **Table B-1** lists all stations in alphabetic order, along with their ranks on a number of key variables, including degree of year-to-year decrease in loads (based on dry season data only) compared against the system-wide average. **Figure B-7** provides the graphical results for each station, all in terms of deviation from the overall system average. **Table B-2** provides more detailed information on the specifics of BMPs implemented in each drainage area.

Figures 5 and **B-7**, along with **Table B-2**, show that some discharges demonstrate patterns of decreasing loads that can be related to BMP implementation. However, these data also show that not all drains with a pattern of decreasing loads can be correlated with more intensive BMP implementation, and vice versa.

This analysis approach was not able to clearly show the results of all BMP efforts throughout the watershed. However, it was successful in describing overall patterns and often revealing BMP effects where efforts have been most intensive.

The second analysis approach focused on testing the assumption that reducing discharge loads from individual pipes will reduce the impact of these discharges on the creek receiving water below the discharge. This assumption was tested by performing regressions of impact (downstream minus upstream concentrations) against discharge load for each pipe for both Enterococcus and fecal coliform.

These regressions (**Figures B-8** and **B-9**) show that reduced loads are correlated with reduced impacts at only a subset of the pipes and that results for Enterococcus and fecal coliform differ at the same pipe. Thus, while the first analysis demonstrated that reductions in loads are detectable at some locations, these reductions do not necessarily always result in reductions in impacts in the receiving water. This is largely because the size of impact is strongly influenced by the amount of water in the Creek. Thus, the same load will produce a larger impact if it enters the Creek where flows are low and a smaller impact if it enters the Creek where flow are higher.

Table B-1. Historical monitoring stations, listed in alphabetic order.

"Map ID" refers to station identification on Figure 5. "Input Conc" refers to bacteria concentration in the discharge. Each station is ranked from highest to lowest, compared to all other stations, on several key variables, e.g., a "Load Rank" of 5 indicates the 5th highest load overall. "Decrease Rank" is based on year-to-year decrease in loads (or concentration where loads not available) during the dry season. Some data is missing for some stations.

Alpha Order	Station	Map ID	Load Rank	Input Conc Rank	Decrease Rank	Flow (cfs) Rank
1	CTPJ01	41		35	25	
2	J01P01	7	8	21	28	9
3	J01P03	10	5	13	19	8
4	J01P04	11	26	20	32	24
5	J01P05	9	22	17	23	23
6	J01P06	3	19	30	36	11
7	J01P08	1	7	2	9	16
8	J01P21	28	33	36	4	33
9	J01P22	26	17	18	17	19
10	J01P23	25	13	5	33	15
11	J01P24	24	30	31	5	21
12	J01P25	22	28	32	1	20
13	J01P26	23	16	16	29	17
14	J01P27	16	3	1	22	7
15	J01P28	15	11	27	2	5
16	J01P30	14	14	4	13	18
17	J01P33	21	25	10	15	28
18	J01TBN2	4	29	12	7	31
19	J01TBN3	8	27	24	12	29
20	J01TBN4	17	24	19	34	22
21	J01TBN7	20	31	23	26	32
22	J01TBN8	2	32	33	27	25
23	J02P05	30	4	6	31	6
24	J02P08	31	1	7	30	2
25	J02TBN1	29	12	8	3	14
26	J03P01	34		26	24	
27	J03P02	27	2	22	18	1
28	J03P05	33	6	11	8	10
29	J03P13	32	15	28	14	12
30	J03TBN1	35	21	3	21	30
31	J03TBN2	36	20	15	20	27
32	J04	37		25	16	
33	J05	13	18	34	11	3
34	J06	12	10	29	35	4
35	J07P01	6	23	9	6	26
36	J07P02	5	9	14	10	13

Table B-2. BMP implementation details in each drainage area.

BMP Category is as in Figure 5, where #1 is basic JURMP Action Plan (inspections, education, enforcement, and promotion of best practices); #2 is #1 + more focused non-structural BMP efforts, # is #1 + structural BMPs, and #4 is all of the above. Loads trends: A is clear decrease; B is clear increase; C is no apparent trend.

Drainage	BMP Category	Loads Trend	BMP Details
CTPJ01	NA	B	
J01P01	1	C	
J01P03	2	B	Catch basin inserts
J01P04	2	B	Catch basin inserts
J01P05	1	B	
J01P06	1	C	
J01P08	2	A	Source ID reconnaissance, focused education programs for likely sources
J01P21	1	A	
J01P22	1	B	
J01P23	1	C	
J01P24	3	A	Partial implementation of catch basis retrofits, trash screens, and filters
J01P25	3	A	CDS unit
J01P26	1	B	
J01P27	1	B	
J01P28	4	A	Sampling, monitoring, and intensive surveillance programs, intensive public education program, strict enforcement of BMPS for commercial facilities, installation of Clear Creek treatment system
J01P30	2	A	Sampling, monitoring, and intensive surveillance programs
J01P33	1	B	
J01TBN2	1	A	
J01TBN3	2	B	Catch basin inserts
J01TBN4	1	C	
J01TBN7	1	B	
J01TBN8	1	B	
J02P05	2	C	Sampling and monitoring program, intensive education program for homeowners and landscapers re urban runoff
J02P08	1	B	
J02TBN1	1	A	
J03P01	3	B	Stream restoration for short reach
J03P02	4	B	Intensive surveillance and source ID, education and enforcement, installation of catch basin inserts, temporary dry weather diversion and installation of Clear Creek system (Note: site was upstream of diversion and CCS and thus unaffected by these treatments), installation of WETCAT treatment wetlands
J03P05	1	A	
J03P13	1	A	
J03TBN1	1	C	
J03TBN2	1	B	
J04	3	C	Surveillance program commercial strip mall, strict BMP enforcement for commercial facilitites, partial implementation of catch basis retrofits, trash screens, and filters
J05	3	B	Aliso Hills Channel treatment wetlands
J06	1	B	
J07P01	2	B	Catch basin inserts
J07P02	2	A	Catch basin inserts

Figure B-1. Fecal coliform measurements at and upstream/downstream of discharge points in lower Aliso Creek. The data points are 5-sample moving geometric averages. The data values used in an average are the sample for the date and the four previous samples. The horizontal dashed line represents the Basin Plan REC1 objective for fecal coliforms (geomean not higher than 200/100 ml). The point symbols indicate the year of sampling, with the symbol equal to the last digit of the year (e.g., 1 for 2001, 2 for 2002).

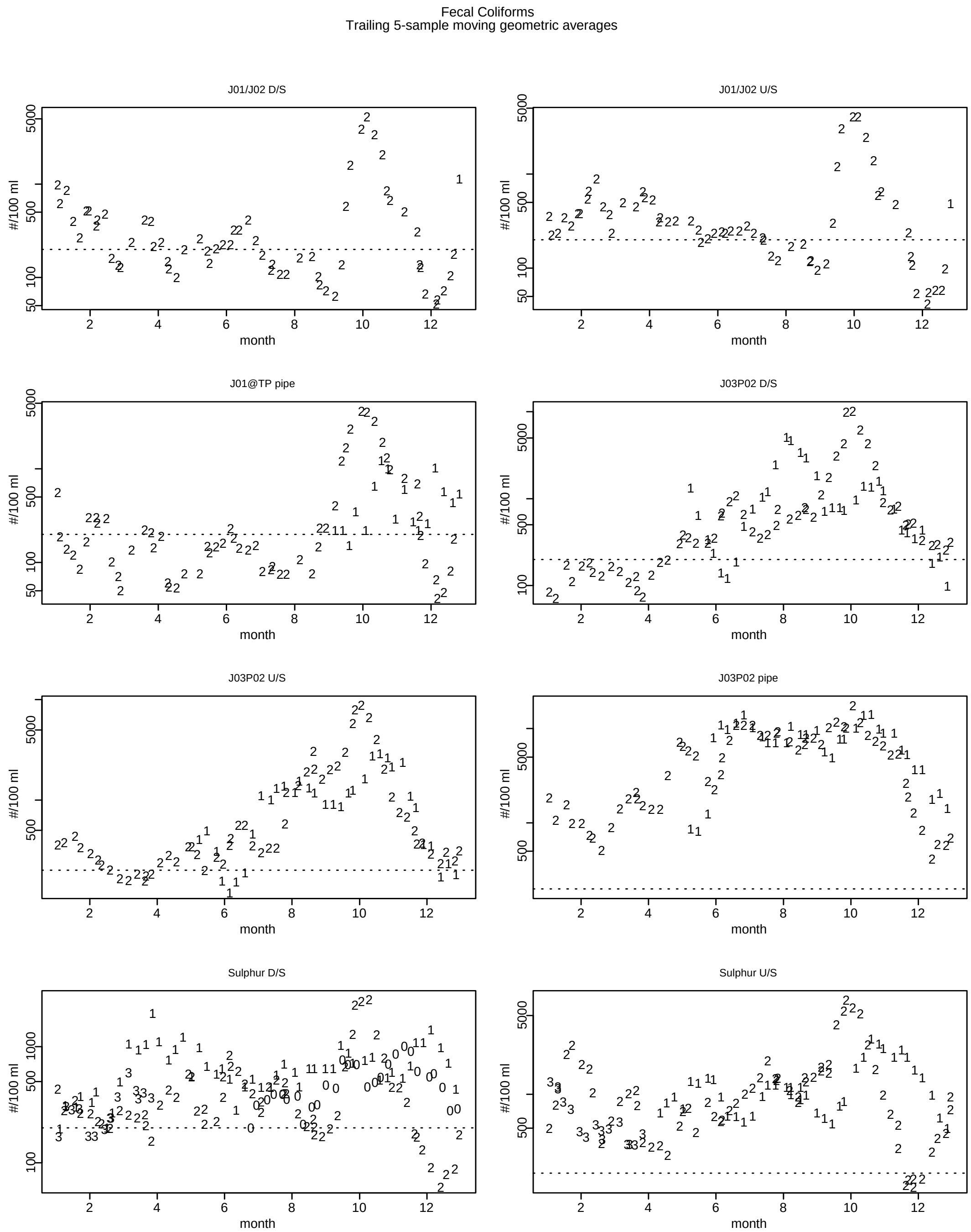


Figure B-2. Fecal coliform measurements at and upstream/downstream of discharge points in lower Aliso Creek. The data points are the percent of fecal coliform samples above 400/100 ml in the five most recent samples. The horizontal dashed line represents the Basin Plan REC1 objective for fecal coliforms (no more than 10% above 400/100 ml). The point symbols indicate the year of sampling, with the symbol equal to the last digit of the year (e.g., 1 for 2001, 2 for 2002).

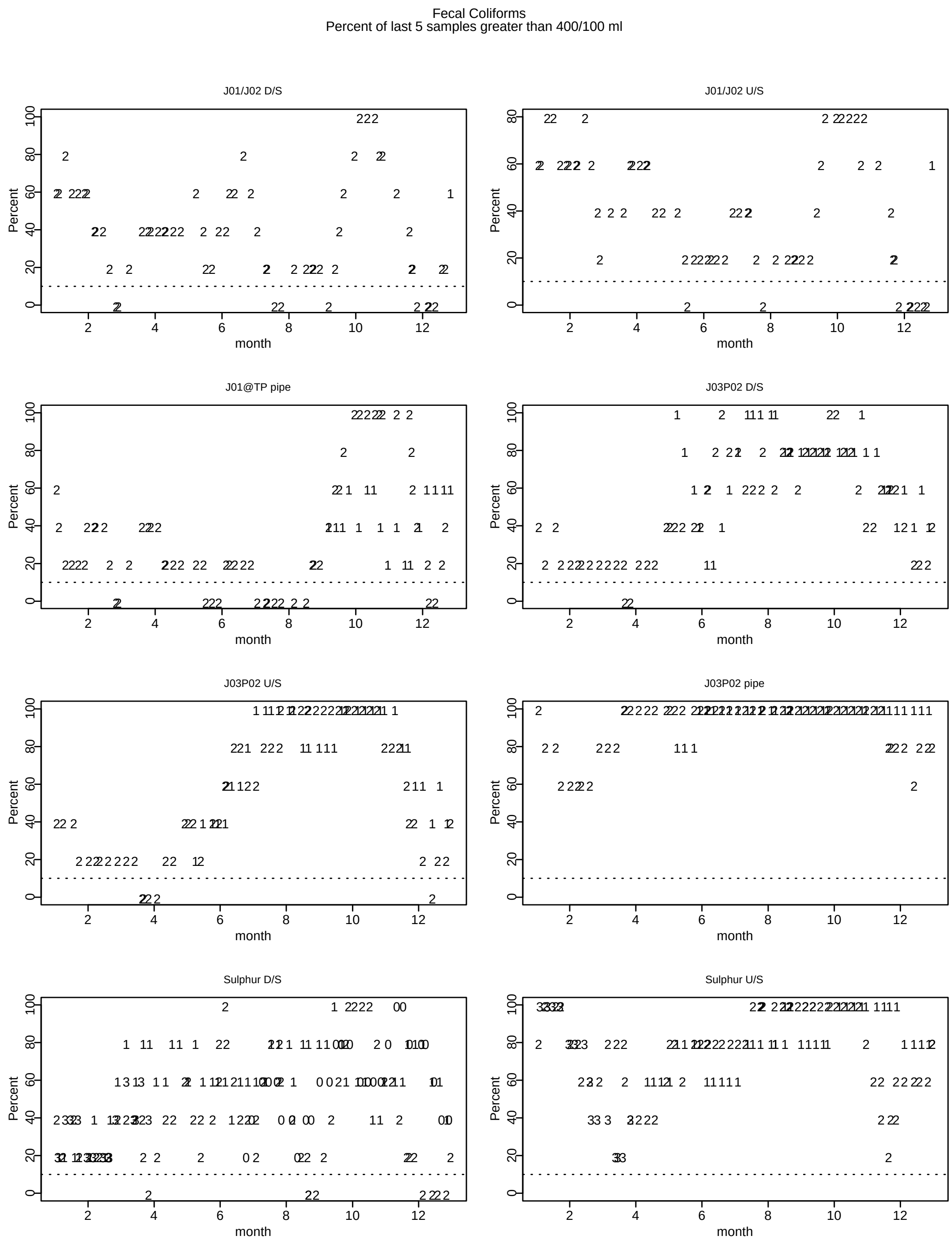


Figure B-3a. Power analysis of a trend monitoring design at the AWMA ROAD Bridge, station Sulphur Creek upstream. The y-axis shows the amount of change detectable, the x-axis the years of sampling, and the different curves the number of samples in a given 30-day period (5, 10, 20, 40) needed for 80% power.

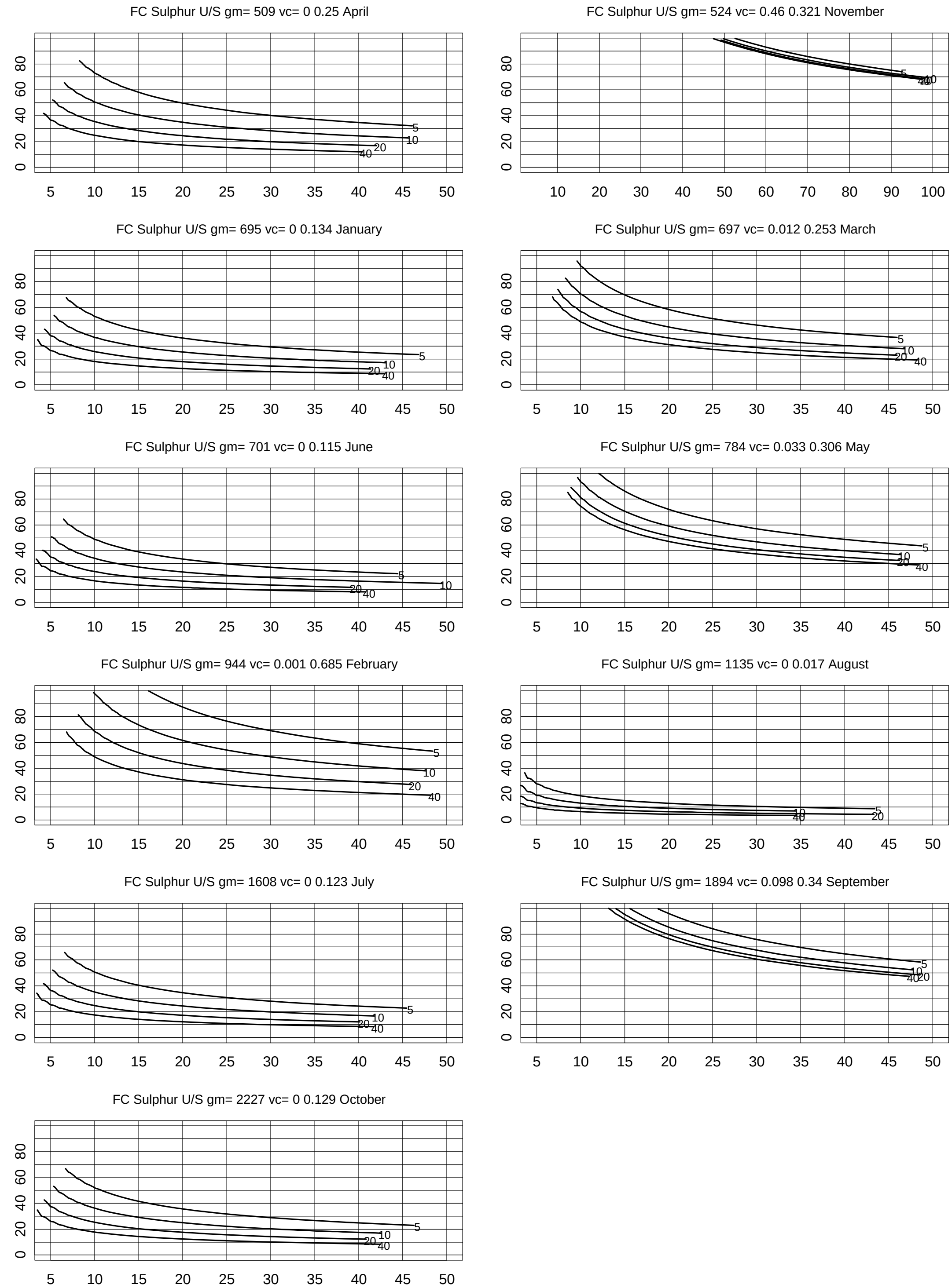


Figure B-3b. Power analysis of a trend monitoring design at the confluence of Aliso and Sulphur Creeks, station J03P02 downstream. The y-axis shows the amount of change detectable, the x-axis the years of sampling, and the different curves the number of samples in a given 30-day period (5, 10, 20, 40) needed for 80% power.

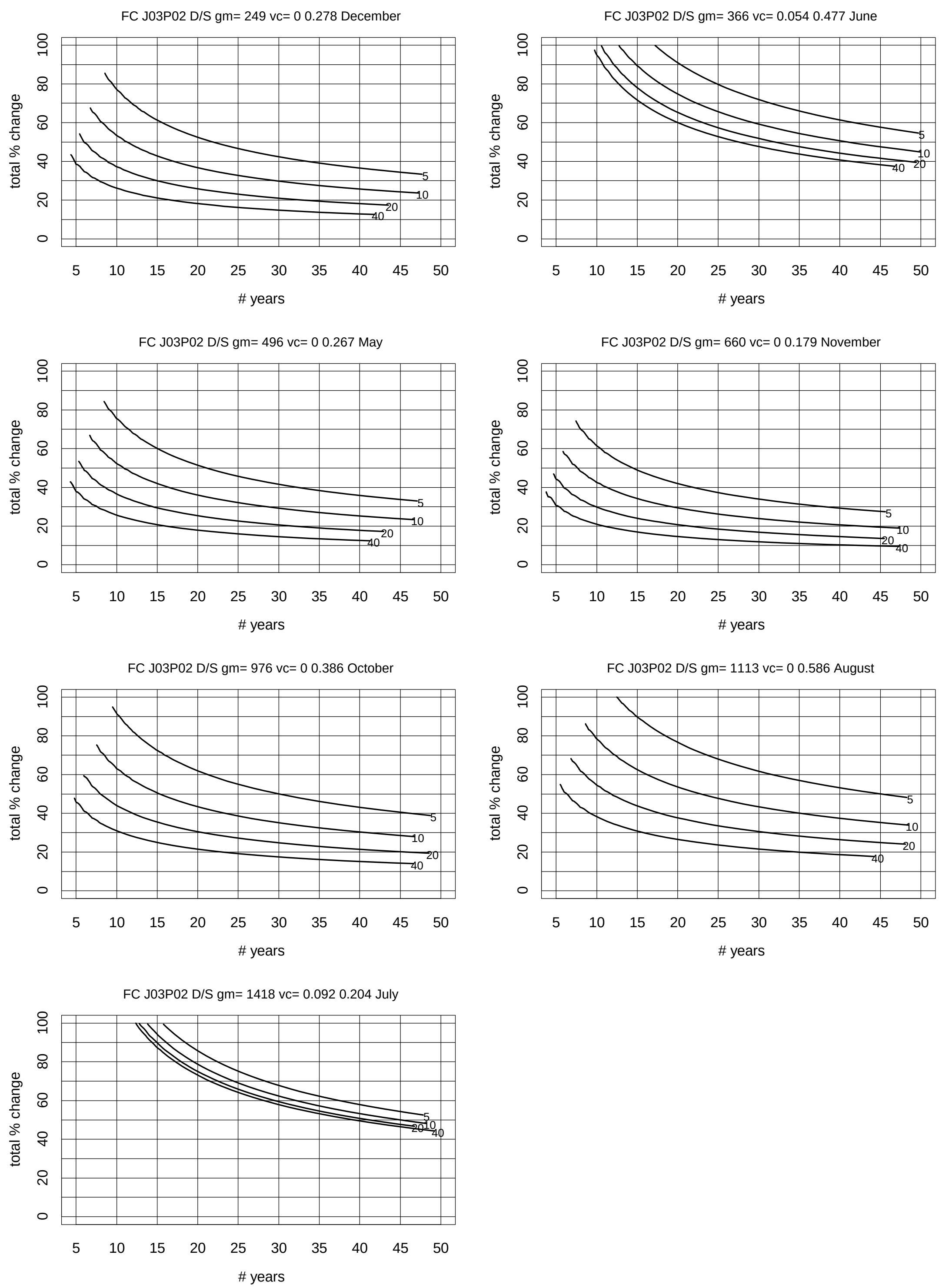


Figure B-3c. Power analysis of a trend monitoring design atAliso Wood Canyon Park, station Sulphur Creek downstream. The y-axis shows the amount of change detectable, the x-axis the years of sampling, and the different curves the number of samples in a given 30-day period (5, 10, 20, 40) needed for 80% power.

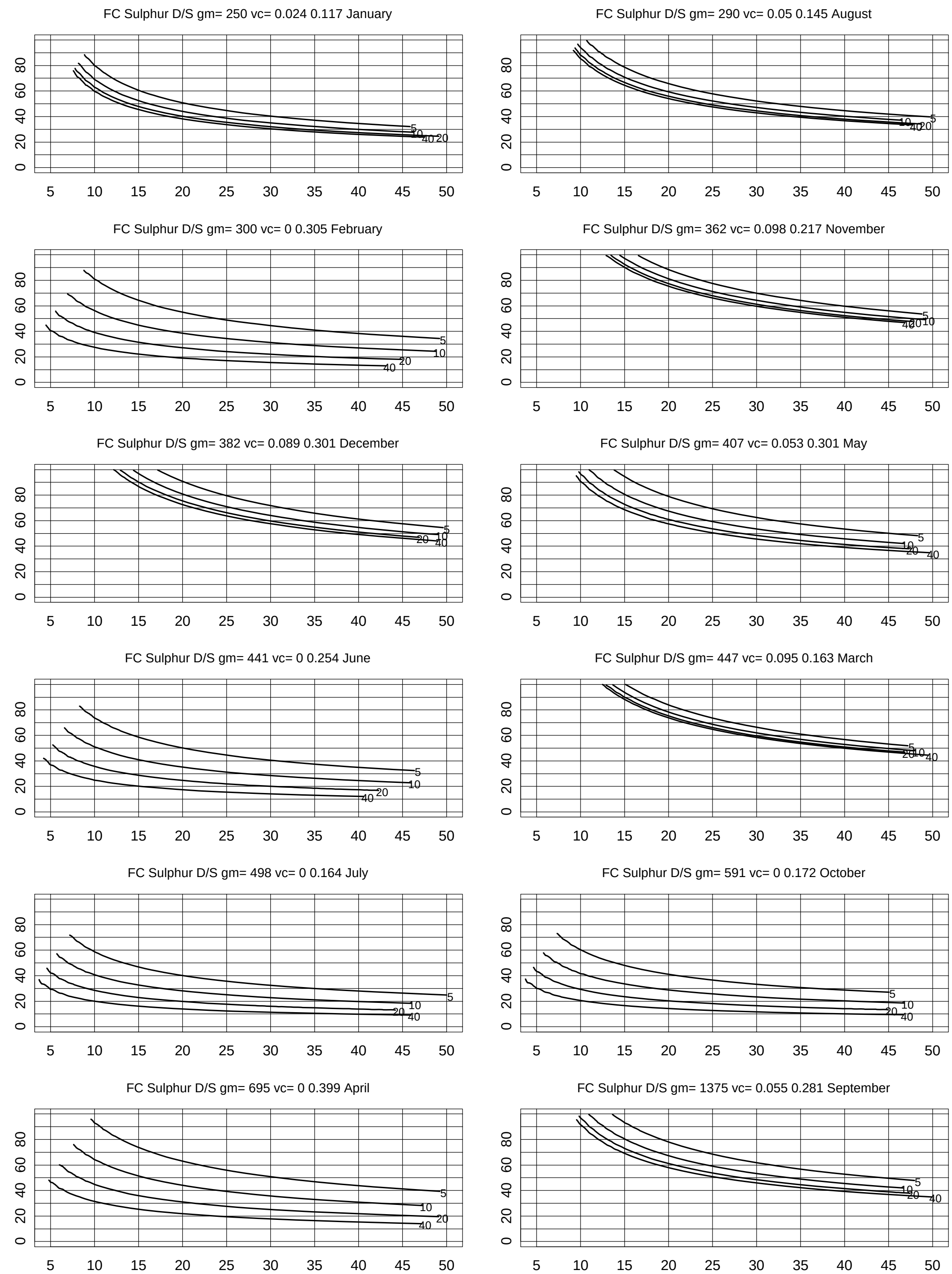


Figure B-3d. Power analysis of a trend monitoring design at the SOCWA treatment plant, station J01@TP. The y-axis shows the amount of change detectable, the x-axis the years of sampling, and the different curves the number of samples in a given 30-day period (5, 10, 20, 40) needed for 80% power.

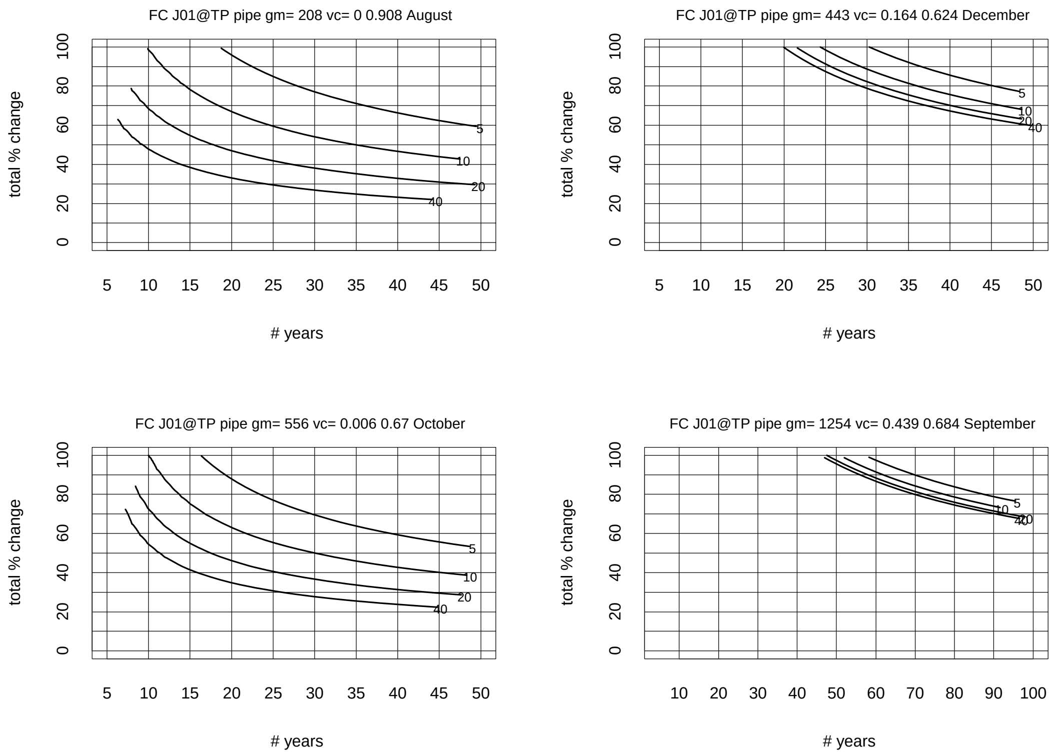


Figure B-4. Fecal coliform levels at the high-priority drains in the Aliso Creek watershed. The dashed line represents the Basin Plan REC1 objective for fecal coliforms (geomean not higher than 200/100 ml).

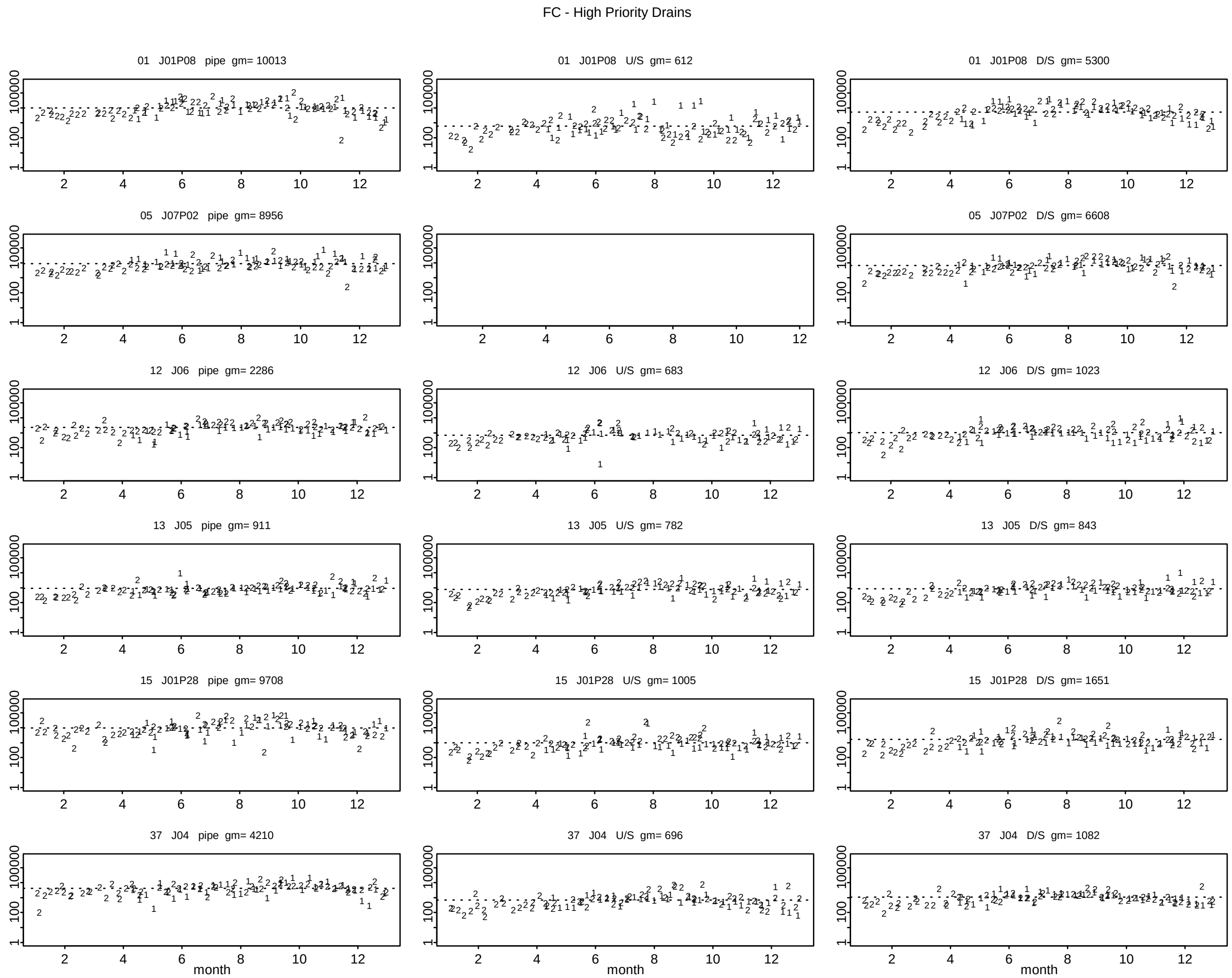


Figure B-5a. Power analysis of a trend monitoring design for fecal coliform loads at the high-priority drains in the Aliso Creek watershed. The y-axis shows the amount of change detectable, the x-axis the number of years sampling, and the different curves the number of samples in per year (5, 10, 20, 40) needed for 80% power. No results are shown for station J04 because the flow was not measured in 2002. Power estimates are based on data from months June – September.

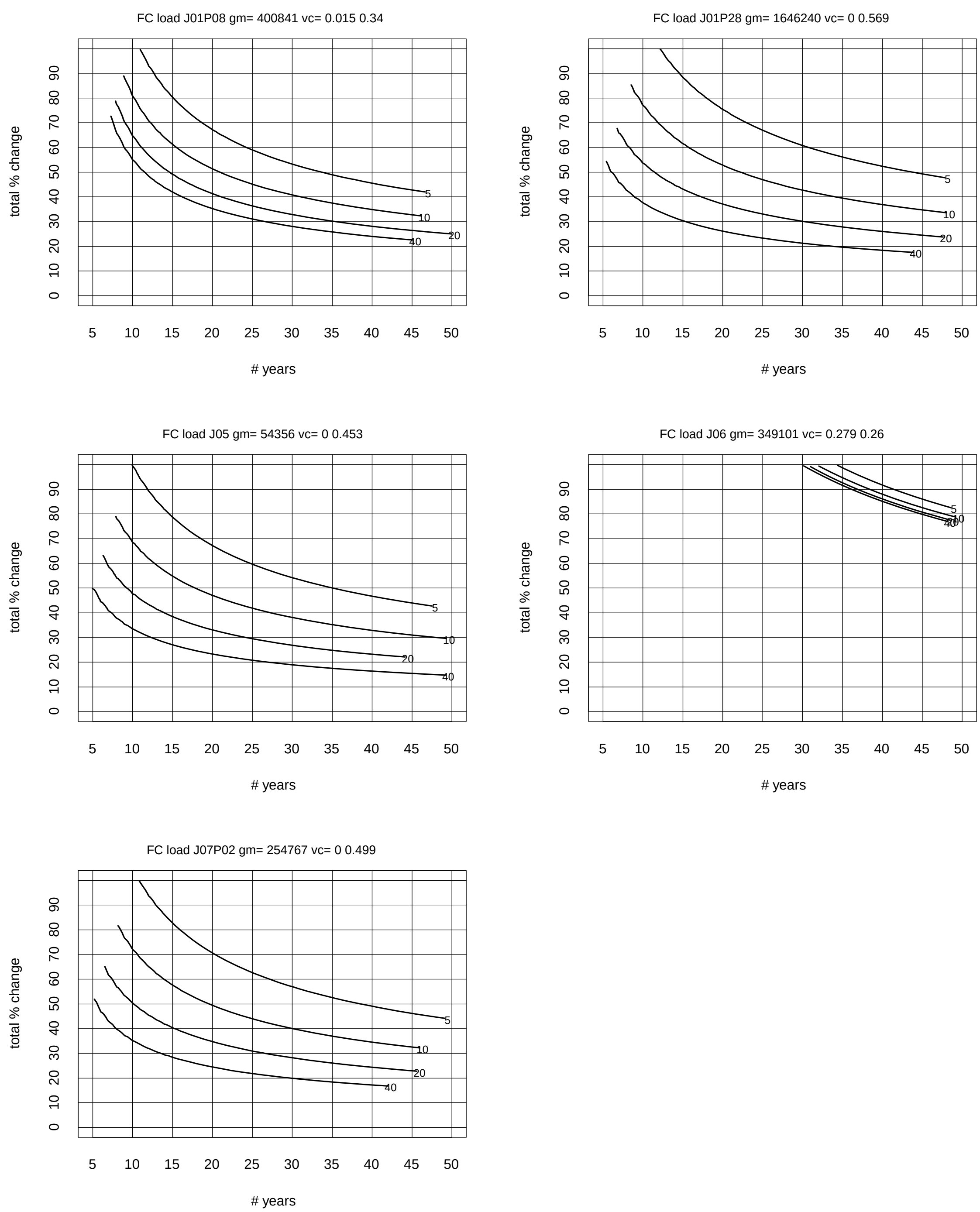


Figure B-5b. Power analysis of a trend monitoring design for fecal coliform loads at the remaining drains in the Aliso Creek watershed. The y-axis shows the amount of change detectable, the x-axis the number of years sampling, and the different curves the number of samples in per year (5, 10, 20, 40) needed for 80% power. Power estimates are based on data from months June – September.

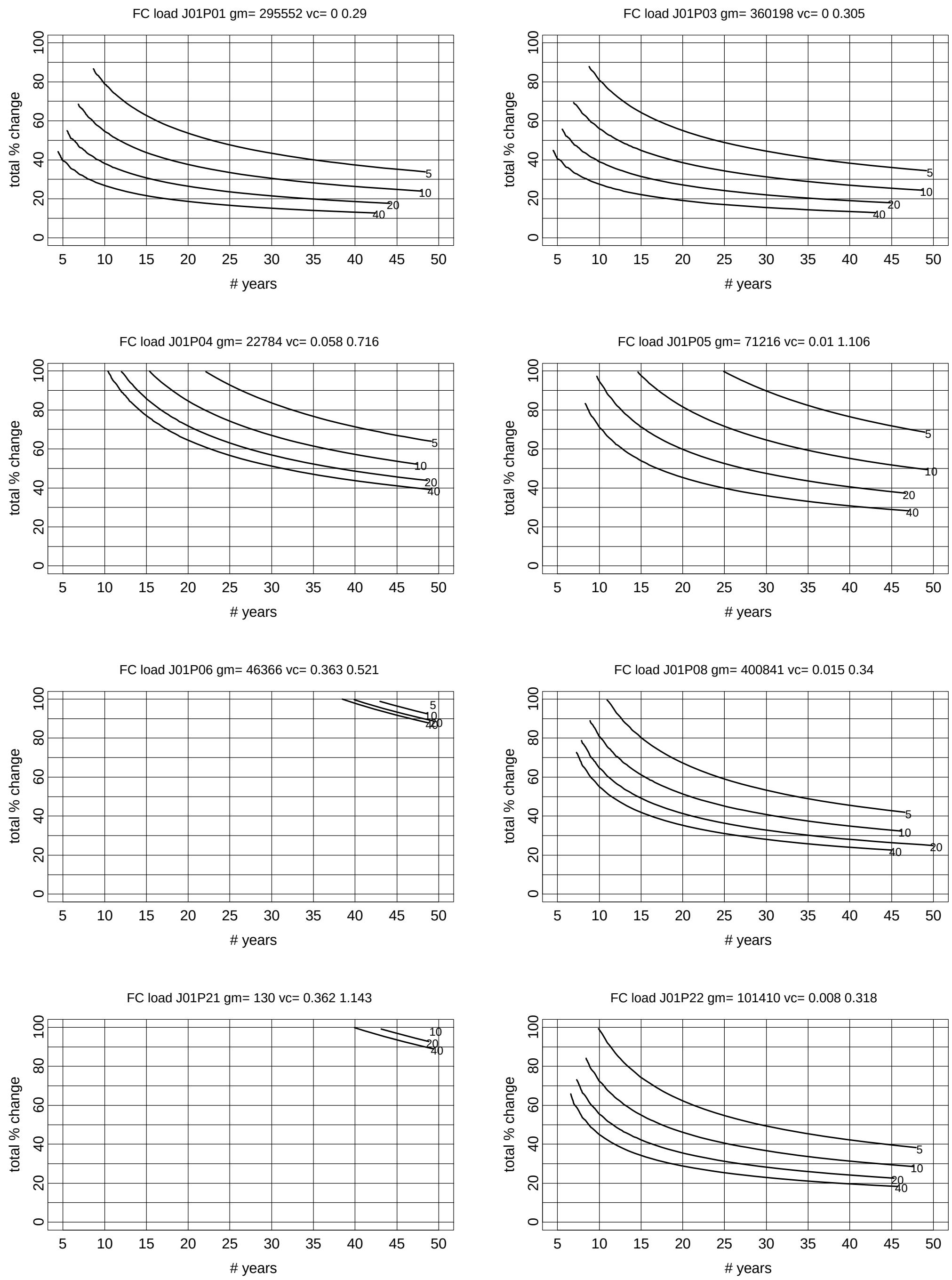


Figure B-5b (continued). Power analysis of a trend monitoring design for fecal coliform loads at the remaining drains in the Aliso Creek watershed.

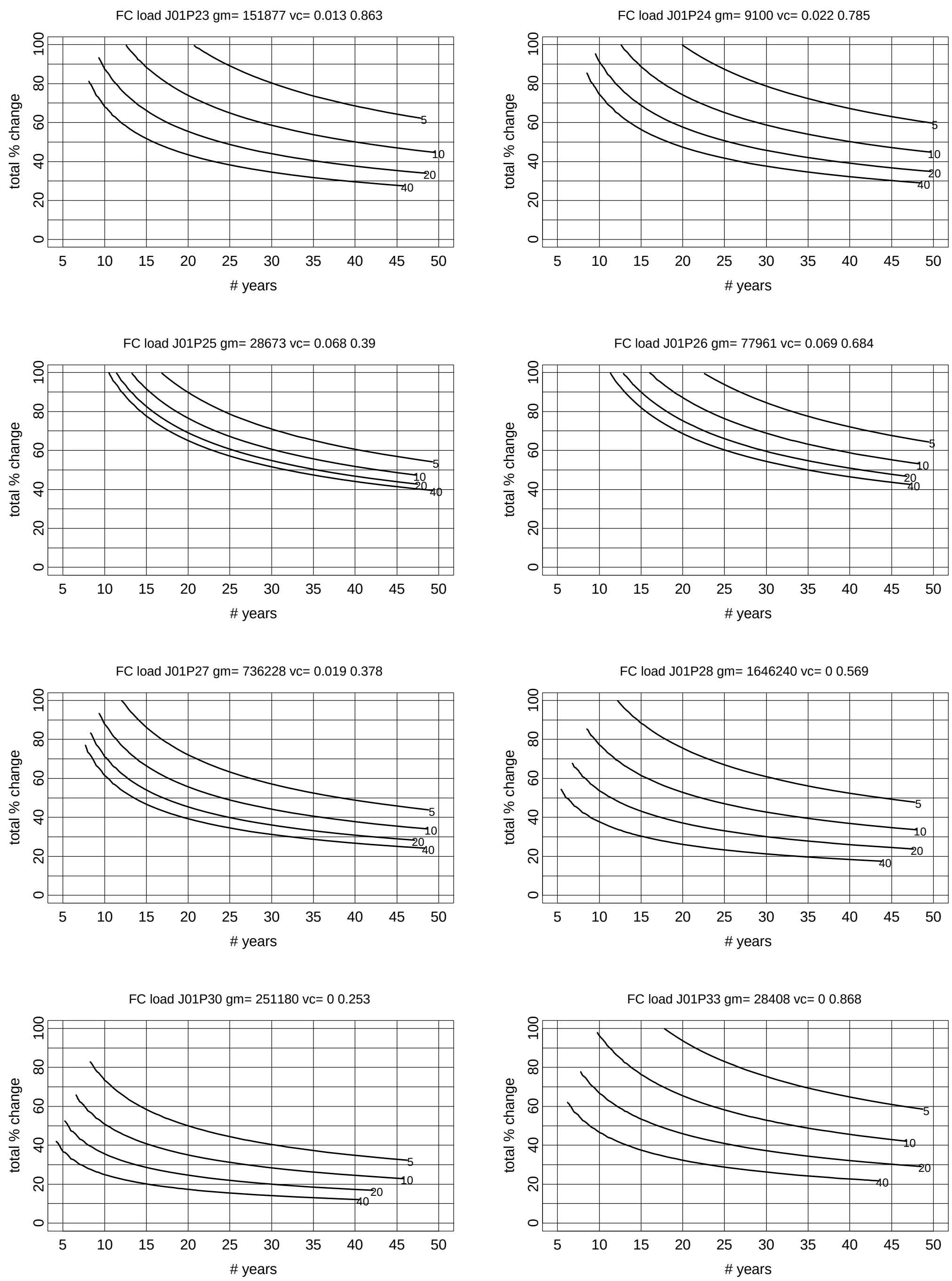


Figure B-5b (continued). Power analysis of a trend monitoring design for fecal coliform loads at the remaining drains in the Aliso Creek watershed.

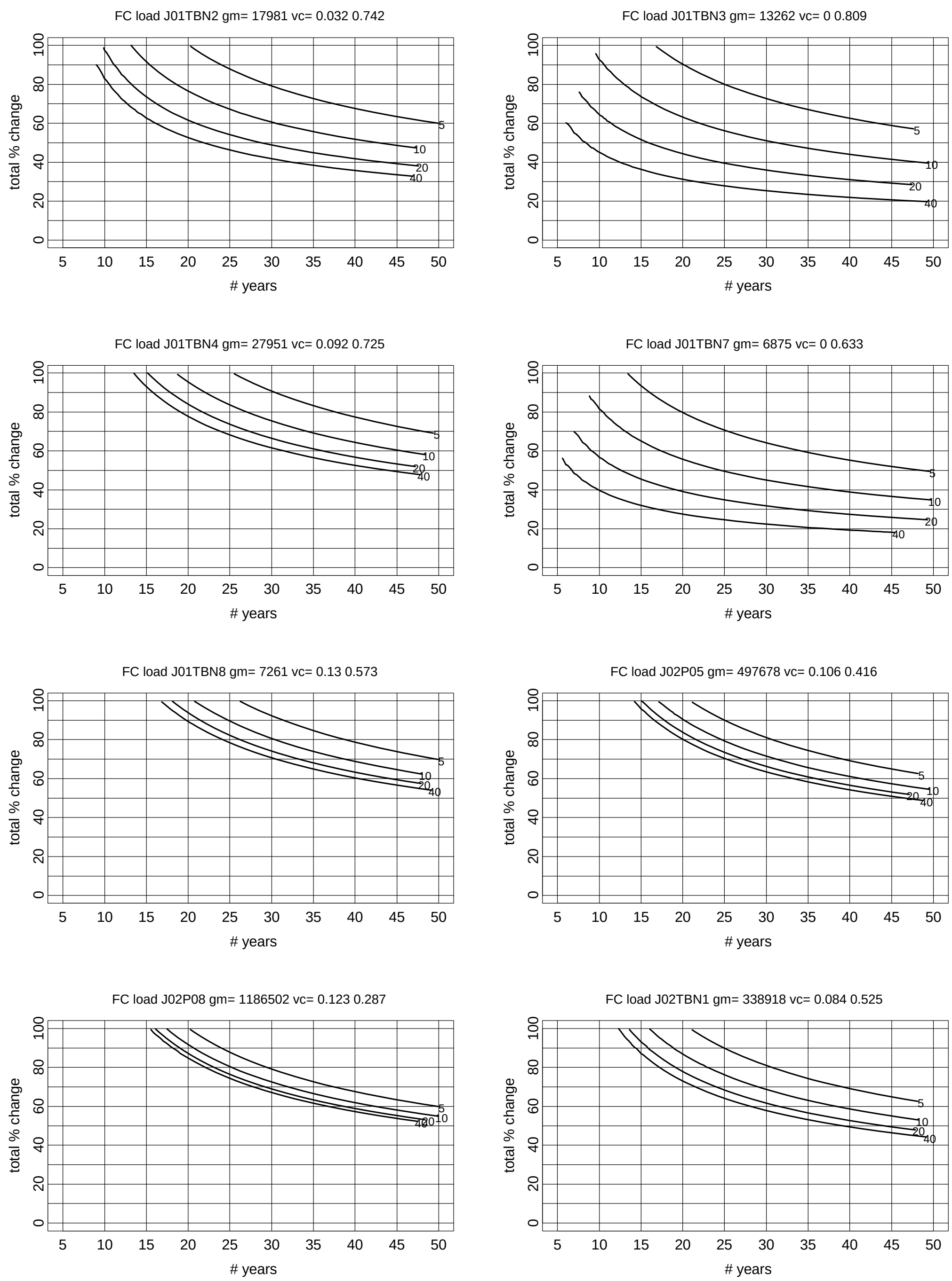


Figure B-5b (continued). Power analysis of a trend monitoring design for fecal coliform loads at the remaining drains in the Aliso Creek watershed.

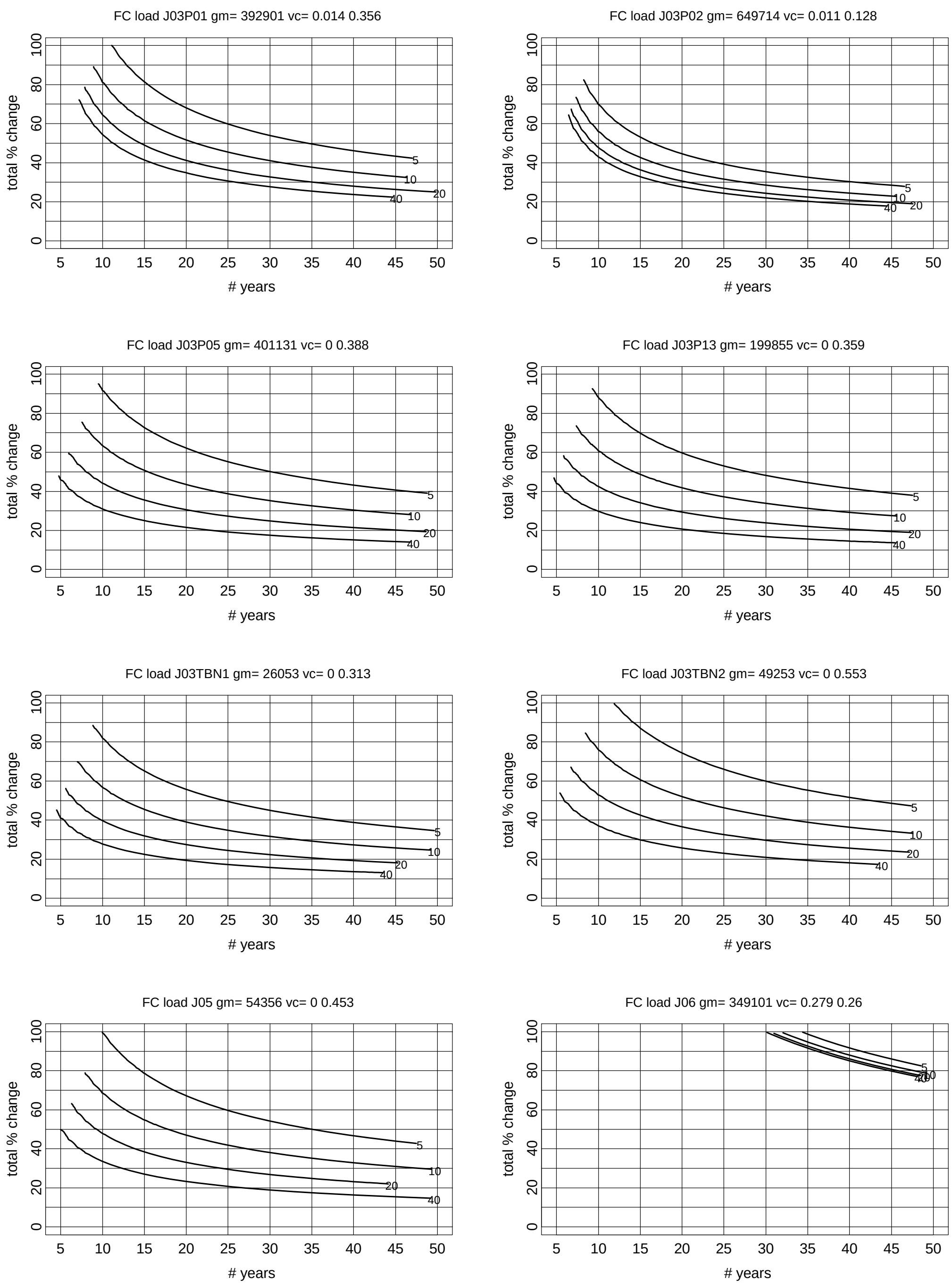


Figure B-5b (continued). Power analysis of a trend monitoring design for fecal coliform loads at the remaining drains in the Aliso Creek watershed.

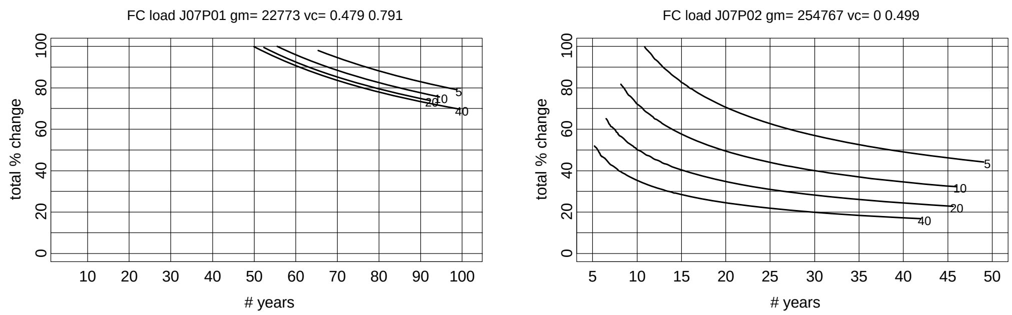


Figure B-6a. Power analysis of a trend monitoring design for fecal coliform impact at the high-priority drains in the Aliso Creek watershed. The y-axis shows the amount of change detectable, the x-axis the number of years sampling, and the different curves the number of samples in per year (5, 10, 20, 40) needed for 80% power. Power estimates are based on data from months June – September.

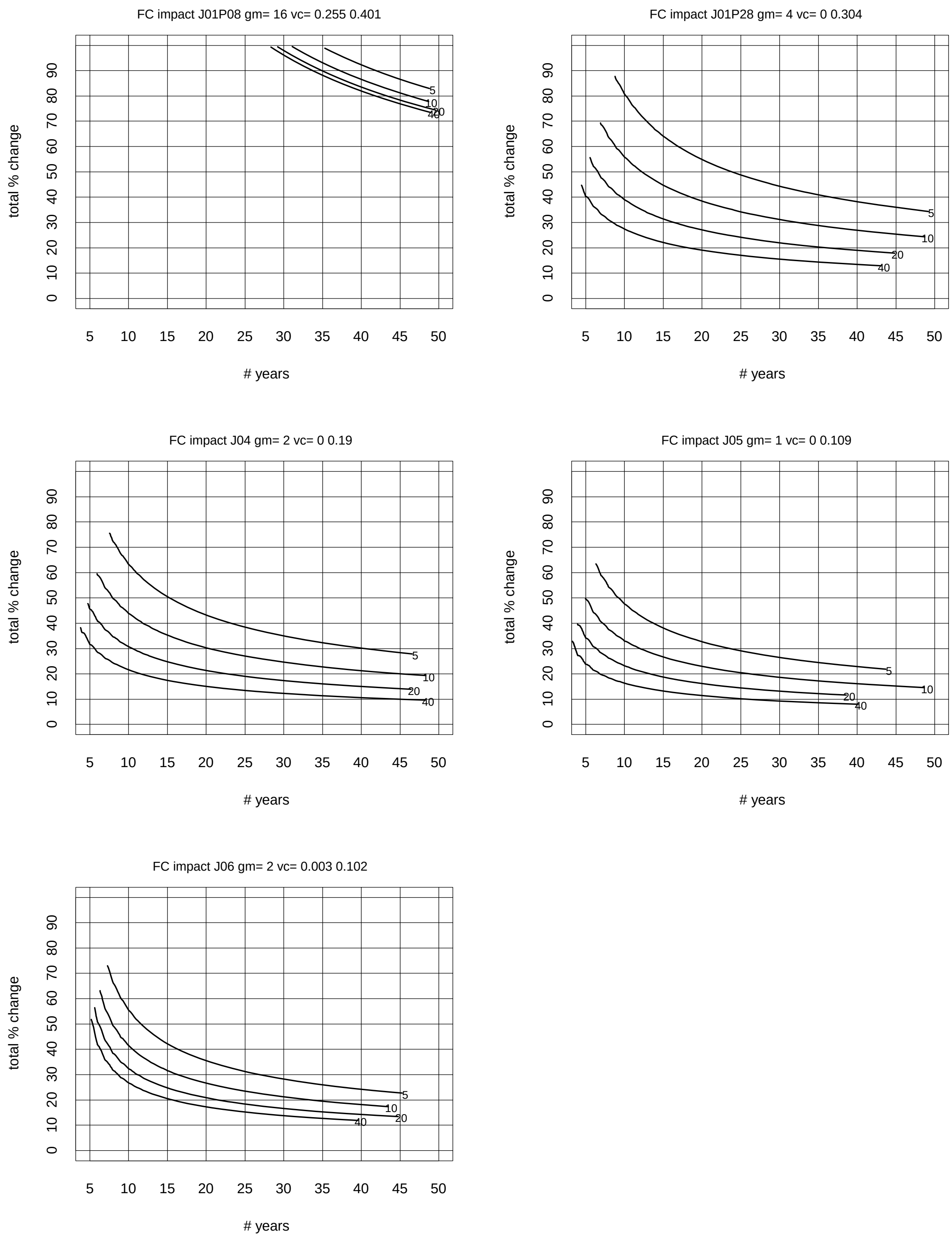


Figure B-6b. Power analysis of a trend monitoring design for fecal coliform impact at the remaining drains in the Aliso Creek watershed. The y-axis shows the amount of change detectable, the x-axis the number of years sampling, and the different curves the number of samples in per year (5, 10, 20, 40) needed for 80% power. Power estimates are based on data from months June – September.

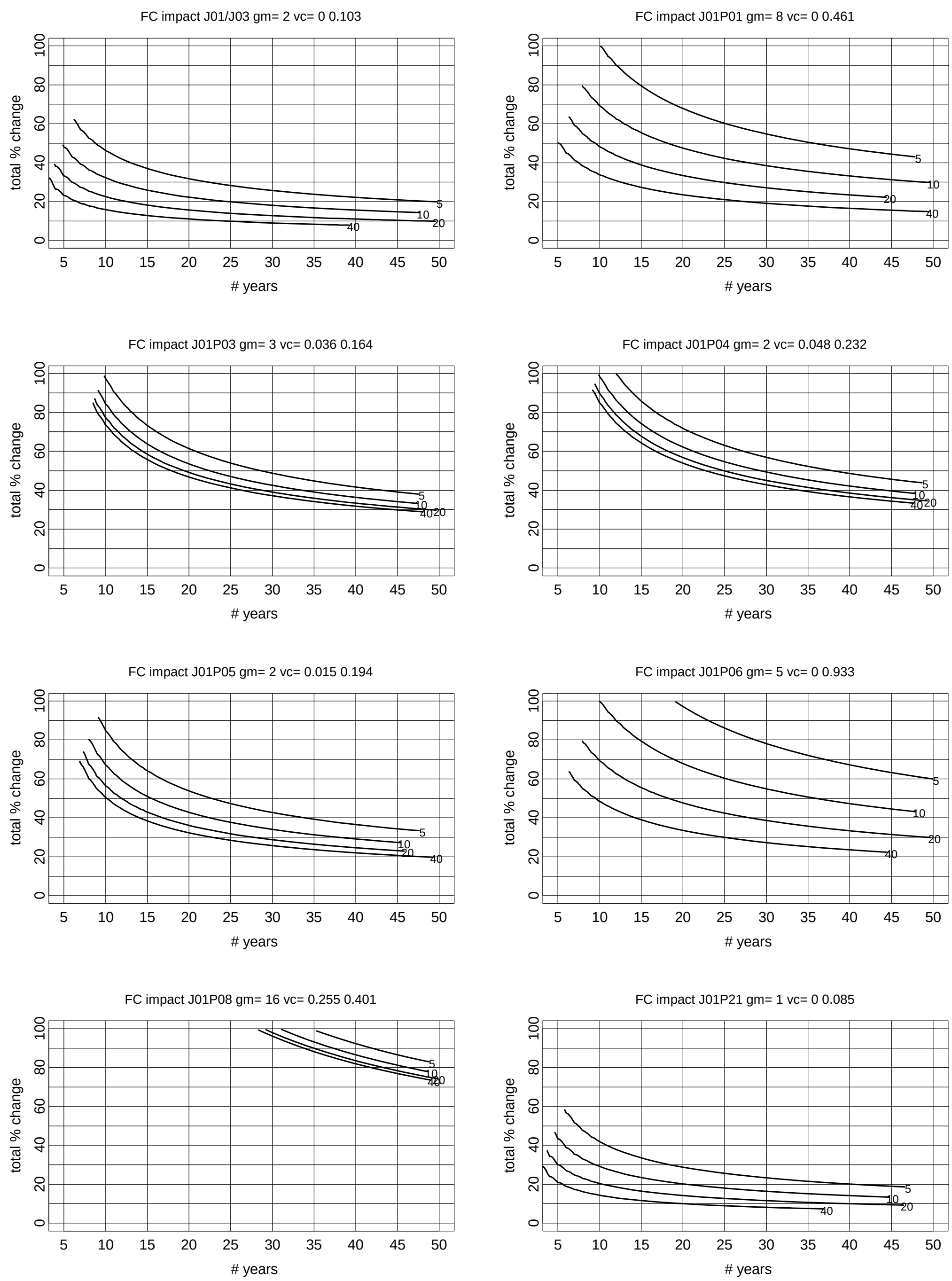


Figure B-6b (continued). Power analysis of a trend monitoring design for fecal coliform impact at the remaining drains in the Aliso Creek watershed.

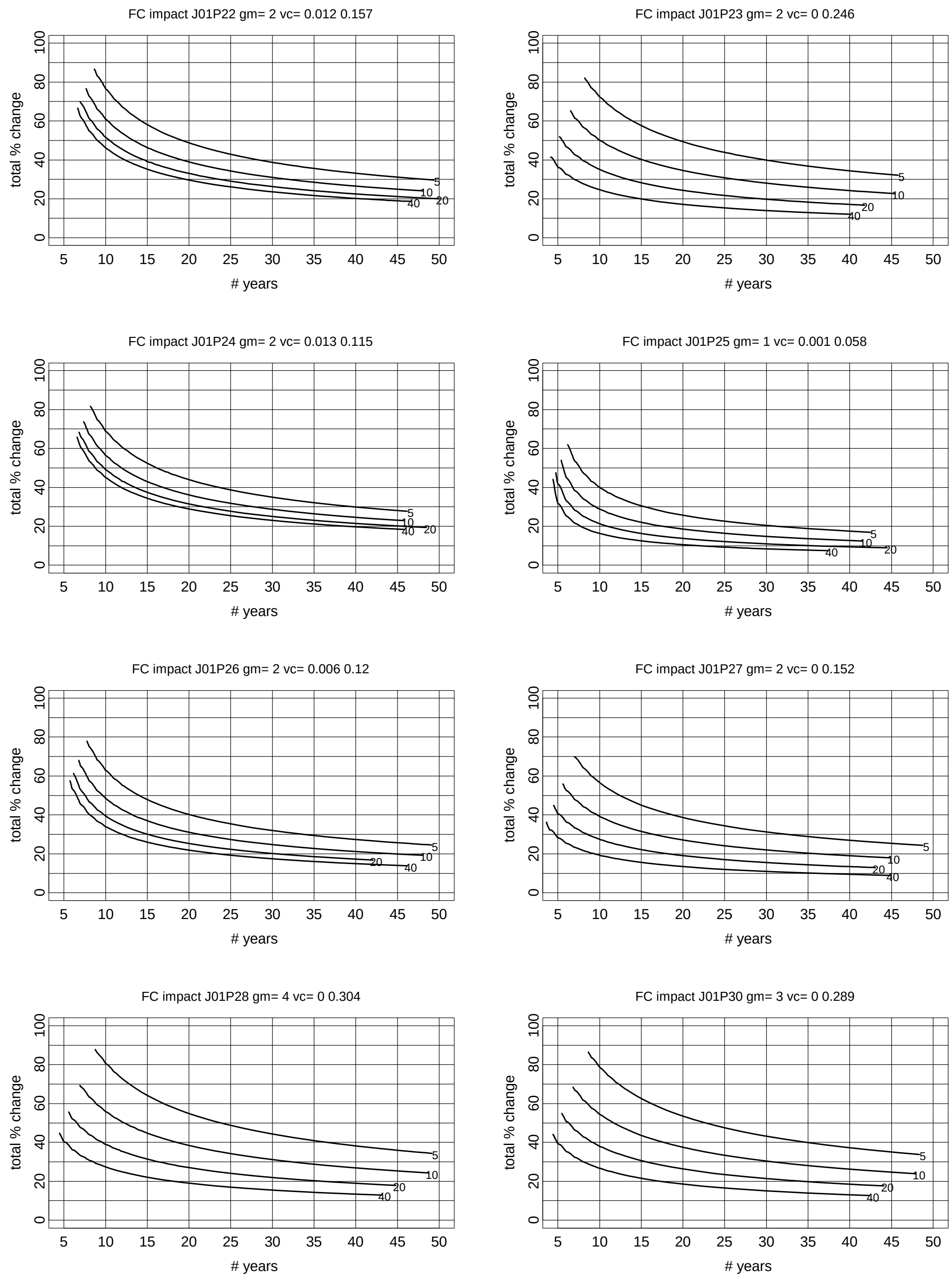


Figure B-6b (continued). Power analysis of a trend monitoring design for fecal coliform impact at the remaining drains in the Aliso Creek watershed.

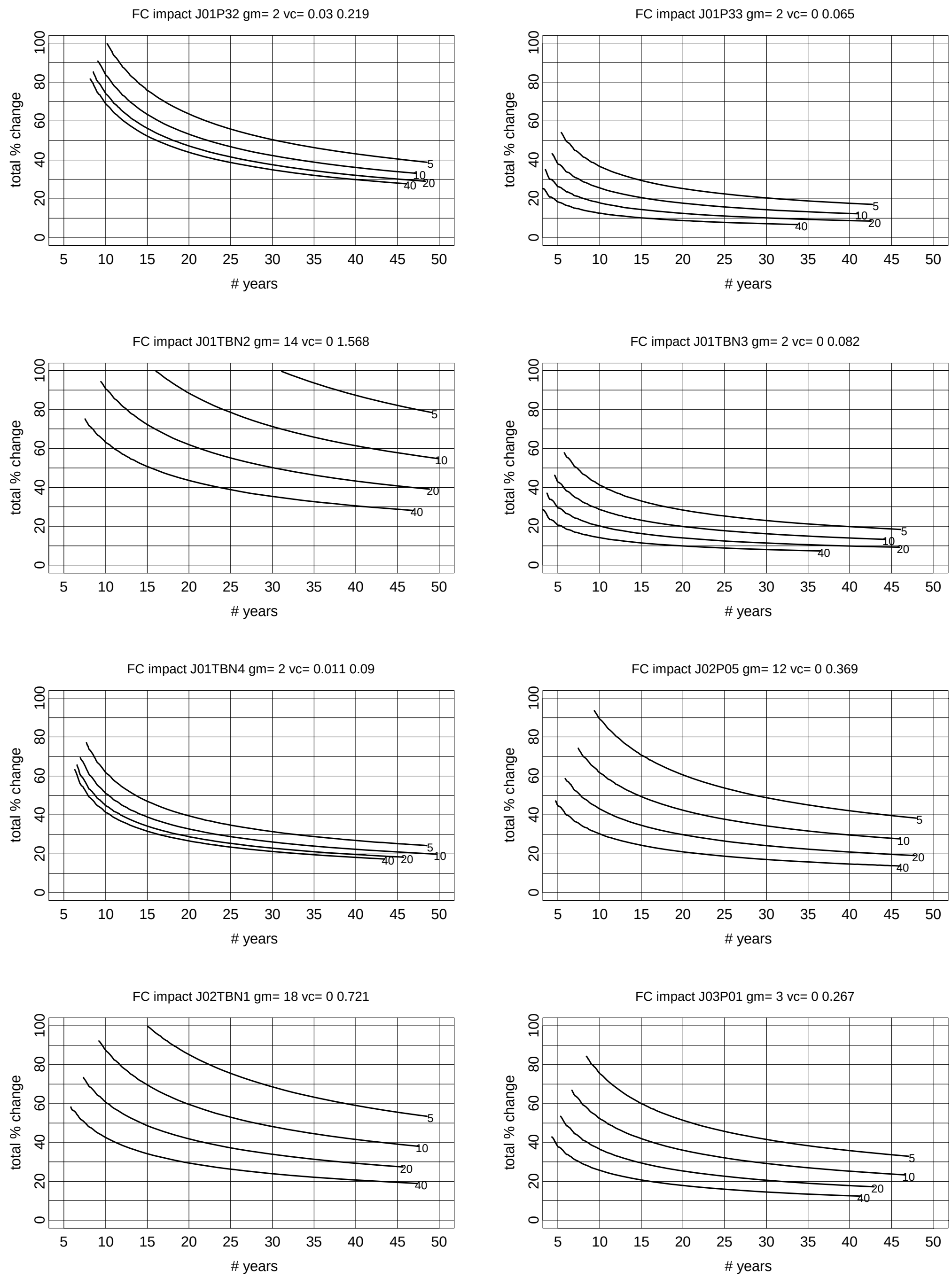


Figure B-6b (continued). Power analysis of a trend monitoring design for fecal coliform impact at the remaining drains in the Aliso Creek watershed.

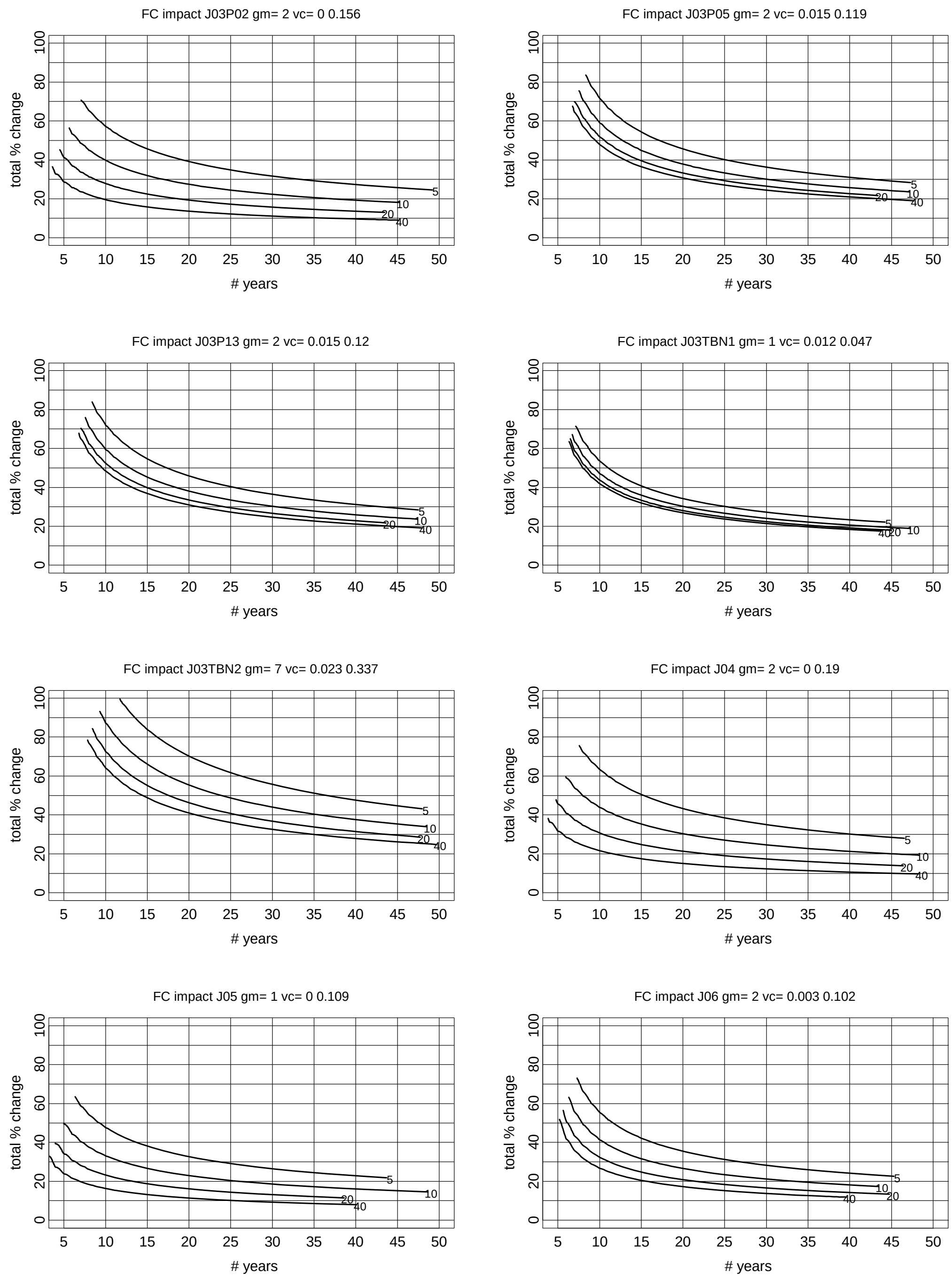
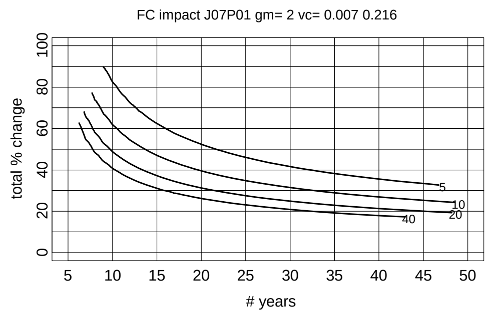


Figure B-6b (continued). Power analysis of a trend monitoring design for fecal coliform impact at the remaining drains in the Aliso Creek watershed.



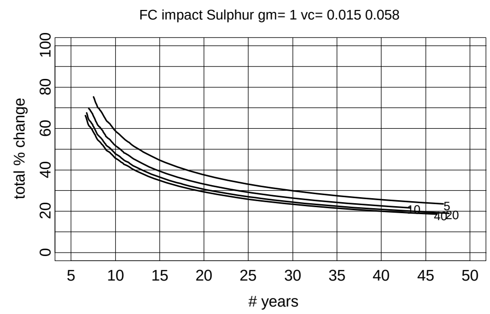
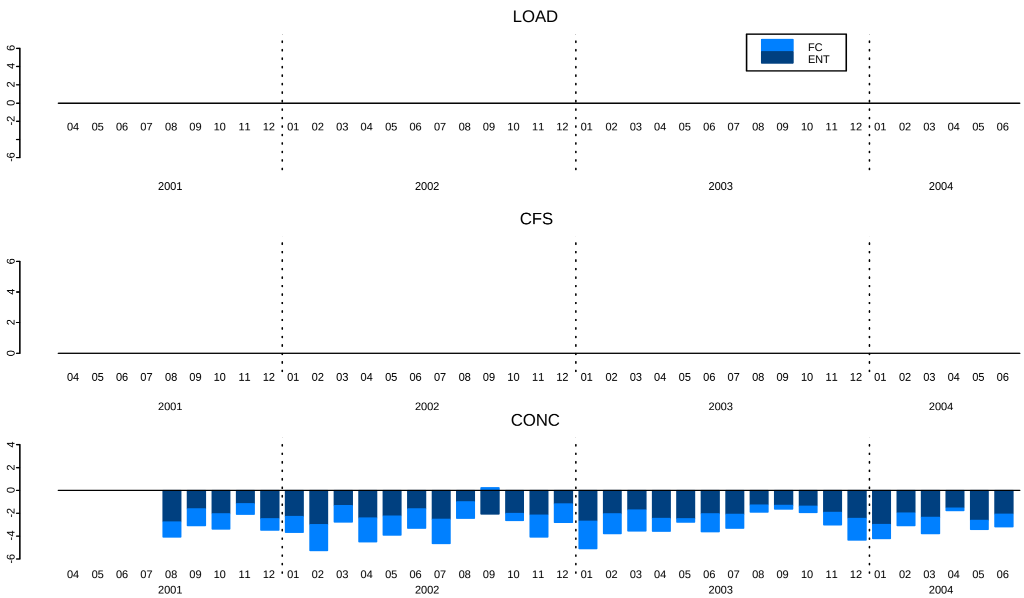


Figure B-7. Patterns of bacterial loads, concentration in the discharge, and discharge flow at all monitored drains. All parameters calculated as deviations from the long-term system mean. The dark portion of each vertical bar indicates Enterococcus and the blue portion fecal coliform. "Load" is bacterial load in the pipe discharge; "CFS" is the measure of flow (cubic feet/second) in the discharge, "CONC" is concentration in the discharge. Rank of this station, from highest to lowest, on each parameter is presented at the top of the figure.

1. CTPJ01



2. J01P01

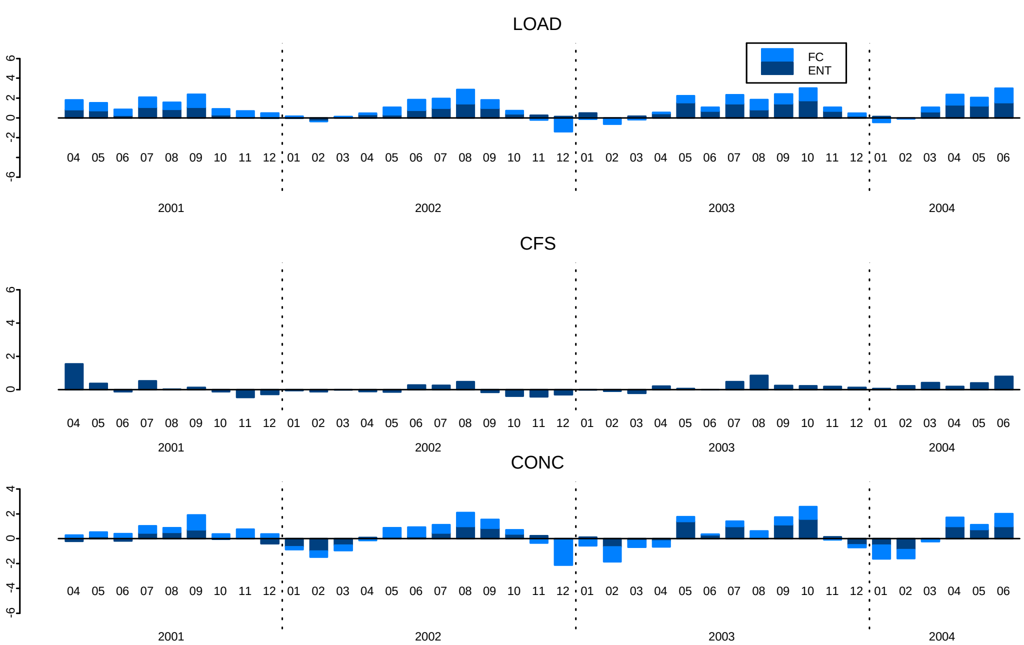
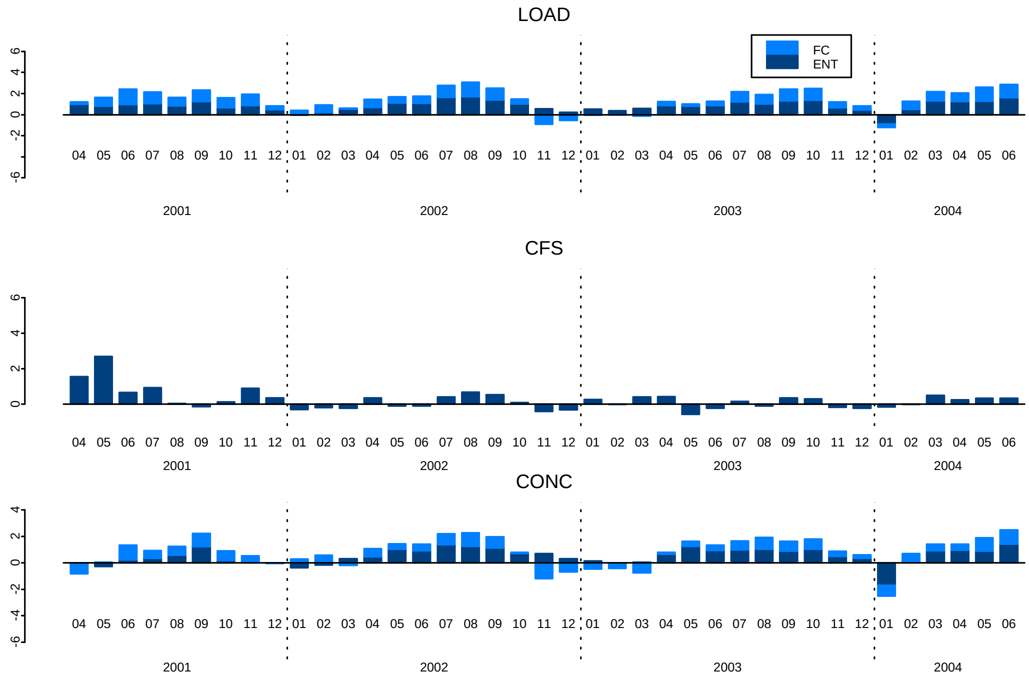


Figure B-7 (continued).

3. J01P03



4. J01P04

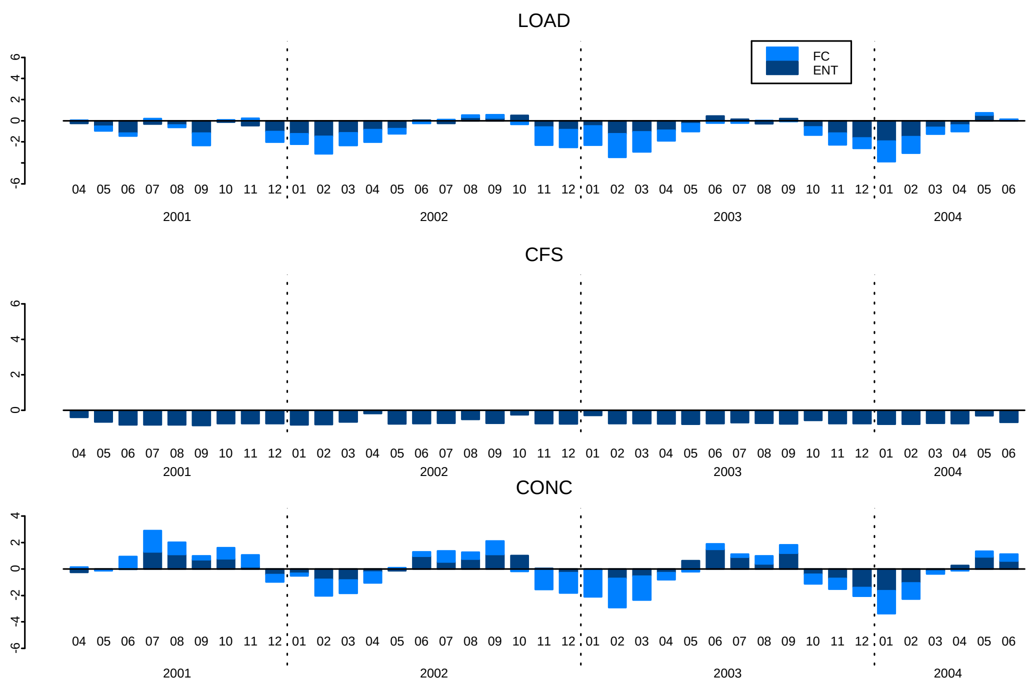
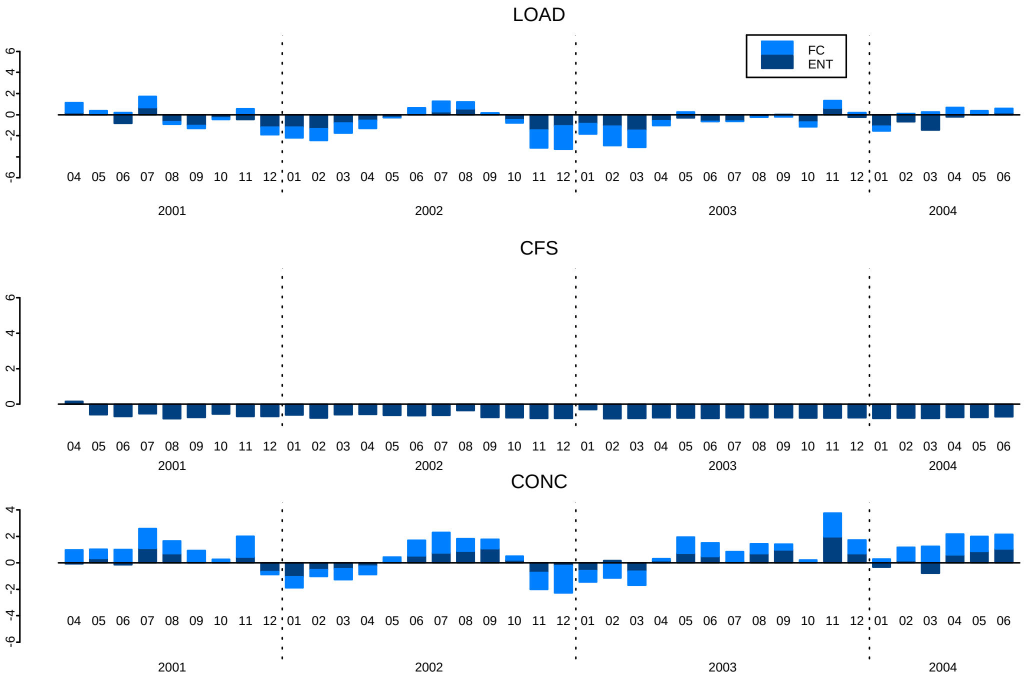


Figure B-7 (continued).

5. J01P05



6. J01P06

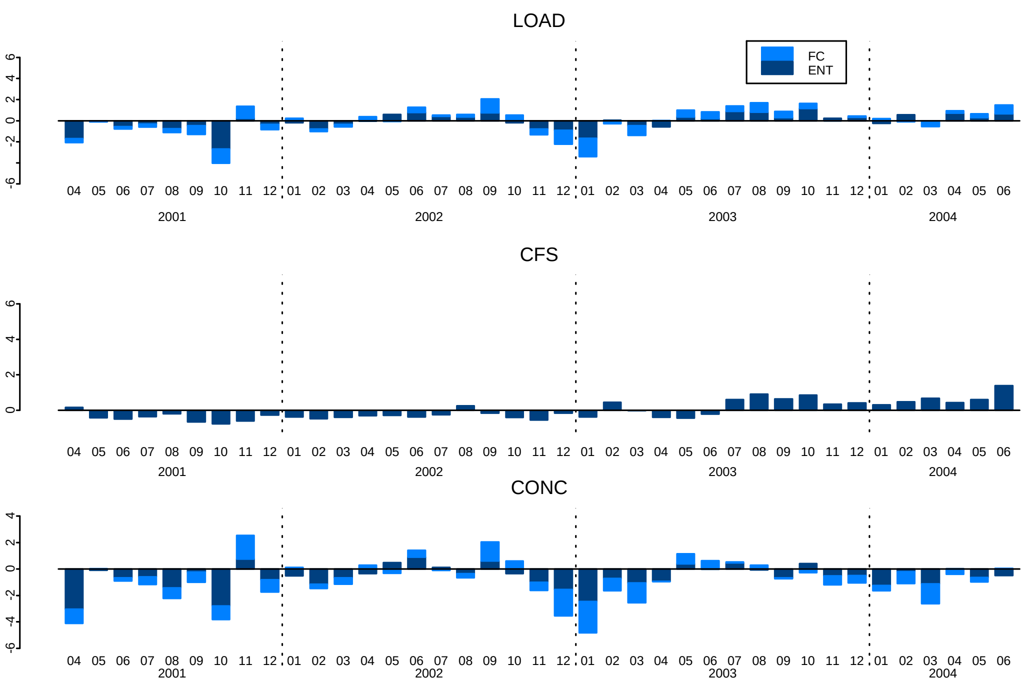
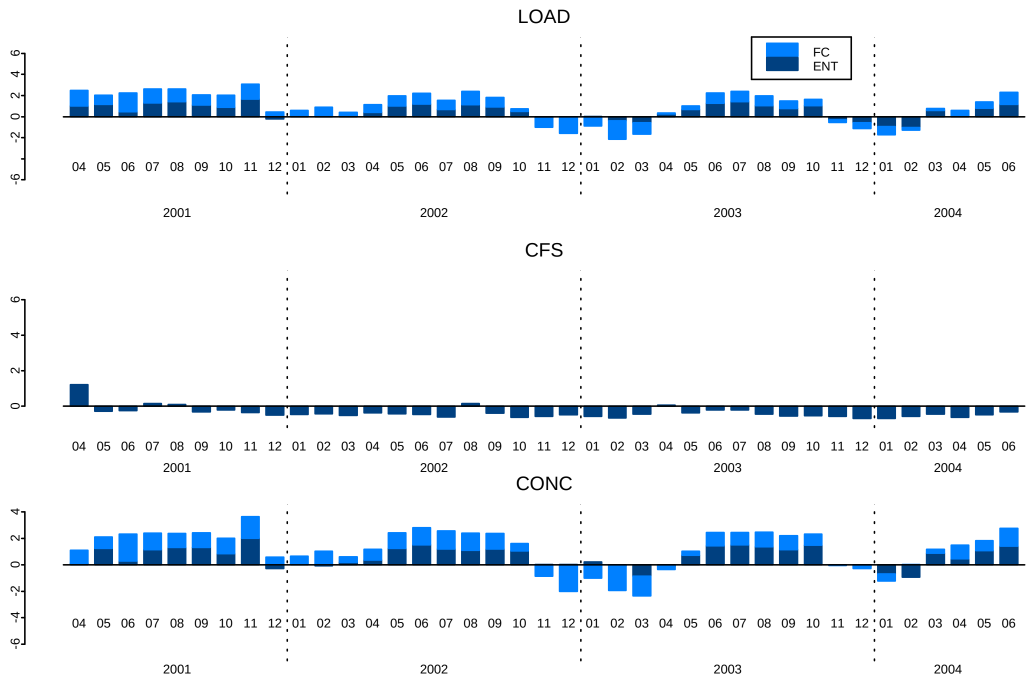


Figure B-7 (continued).

7. J01P08



8. J01P21

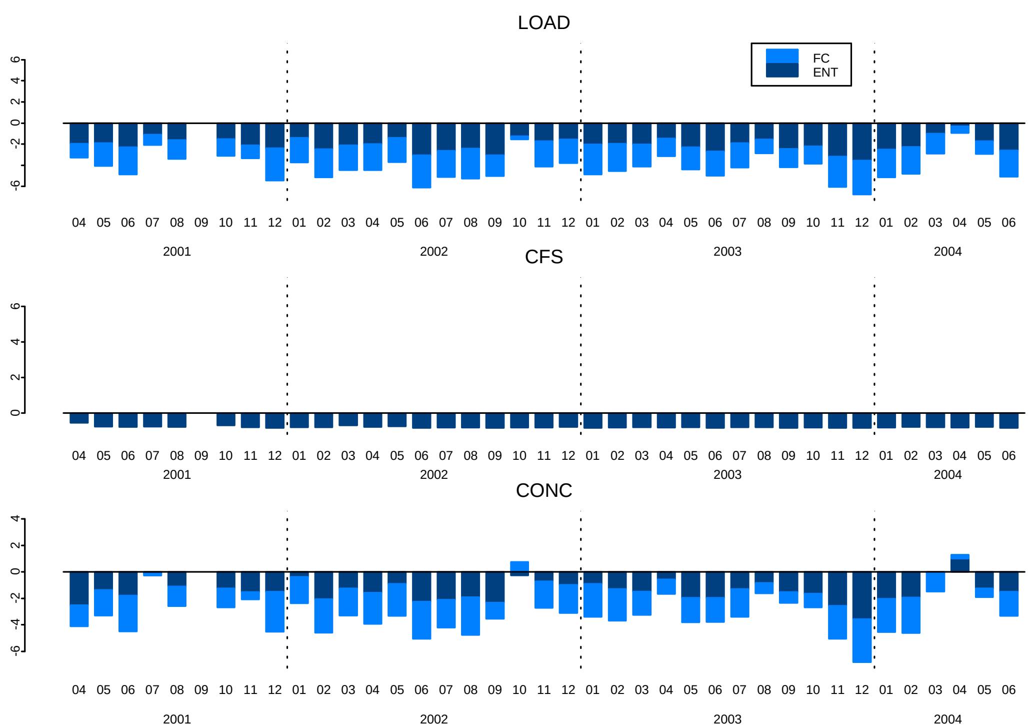
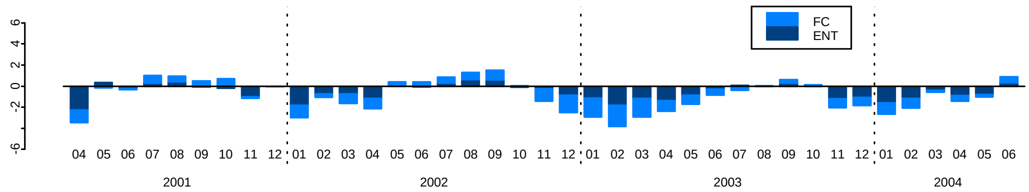


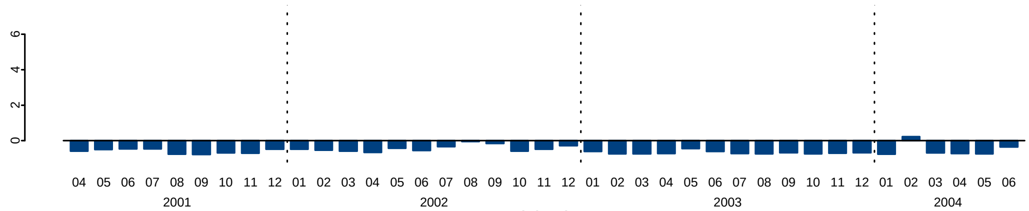
Figure B-7 (continued).

9. J01P22

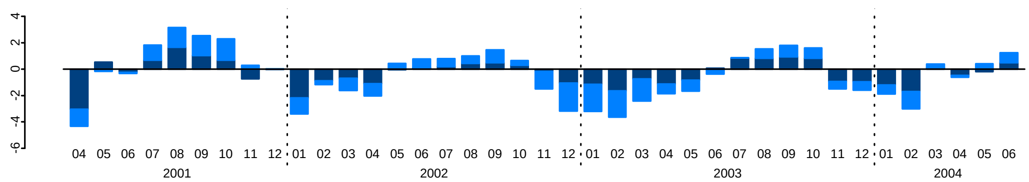
LOAD



CFS



CONC



10. J01P23

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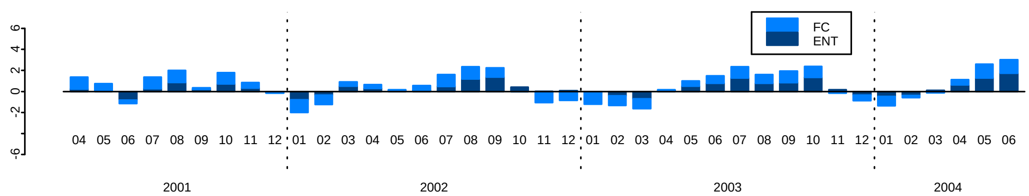
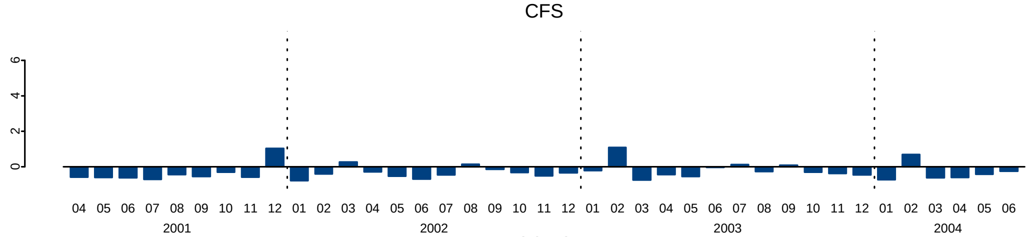


CFS



CONC

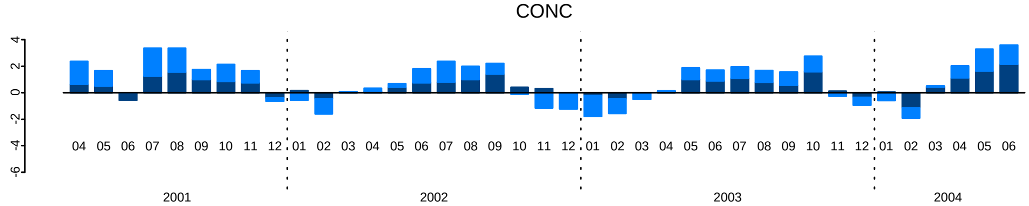
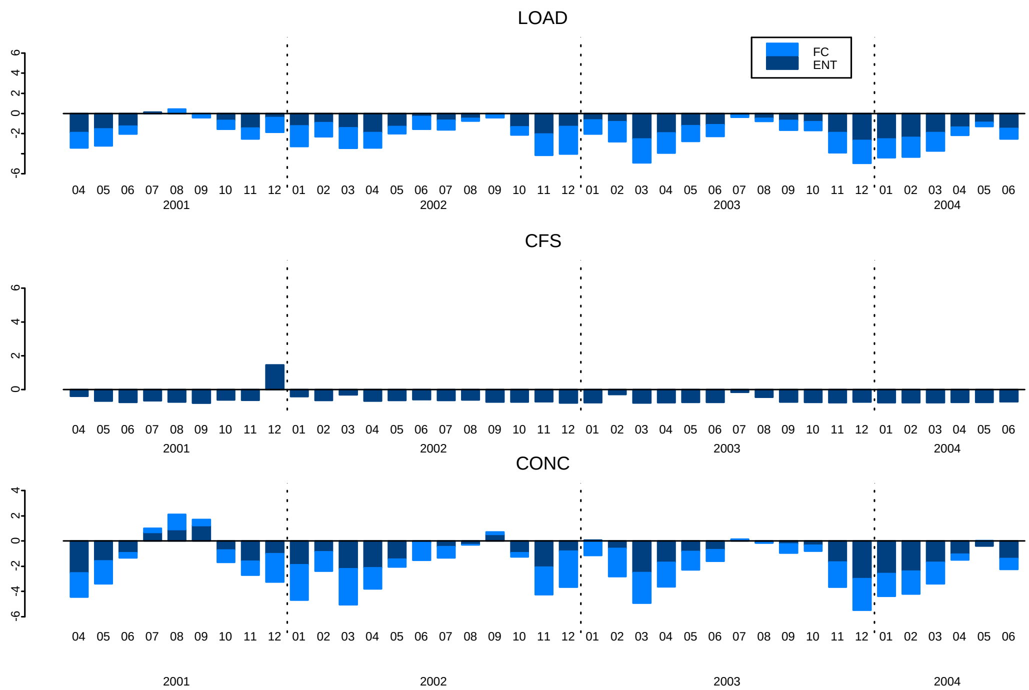


Figure B-7 (continued).

11. J01P24



12. J01P25

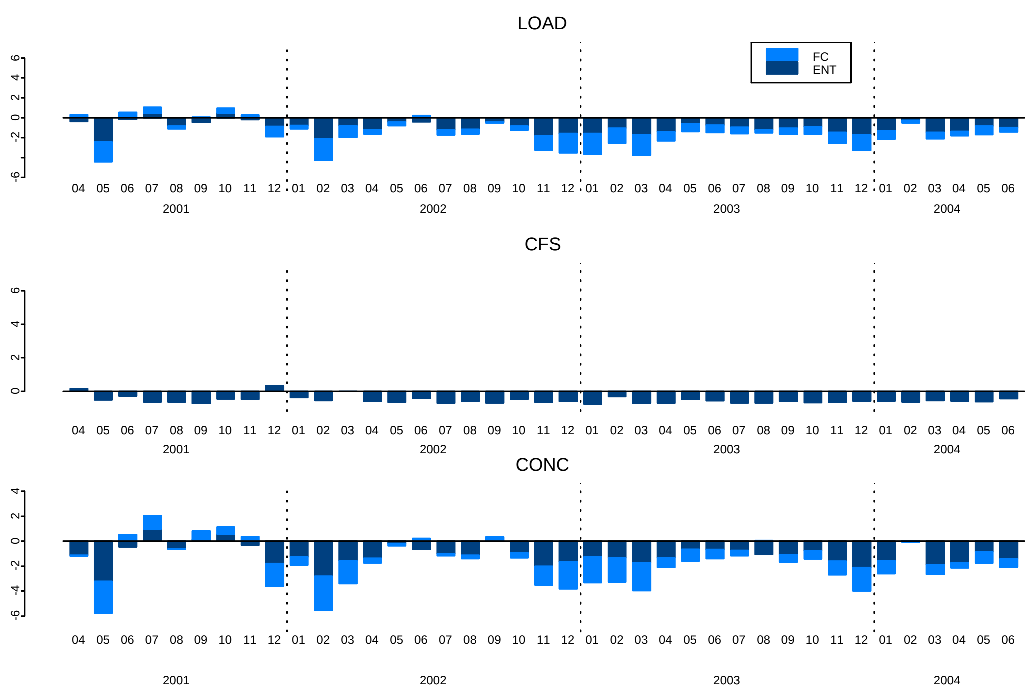
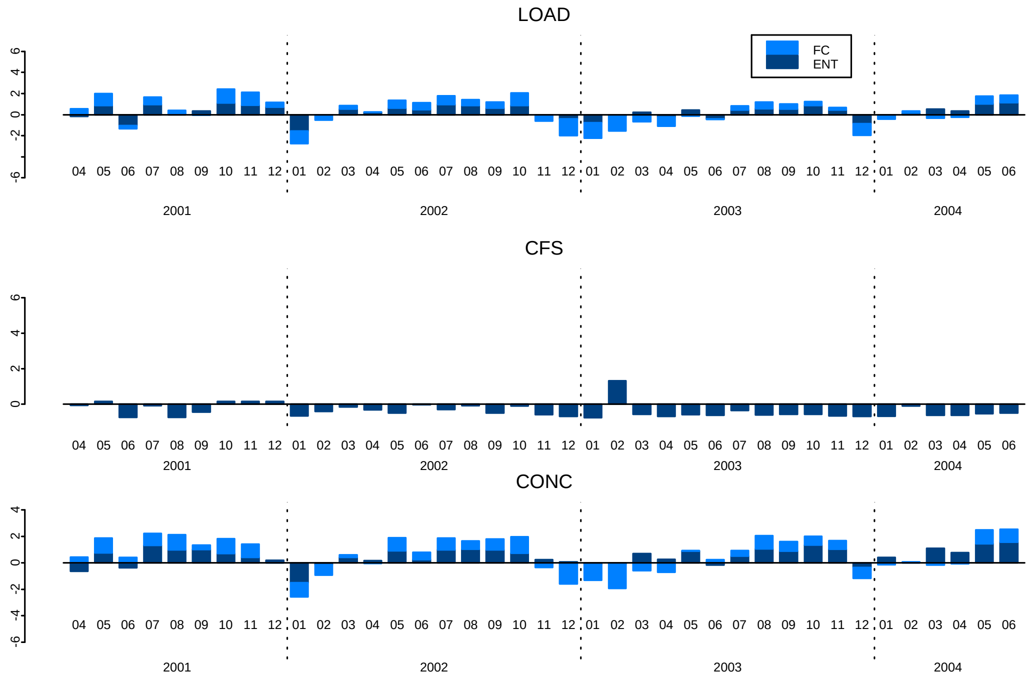


Figure B-7 (continued).

13. J01P26



14. J01P27

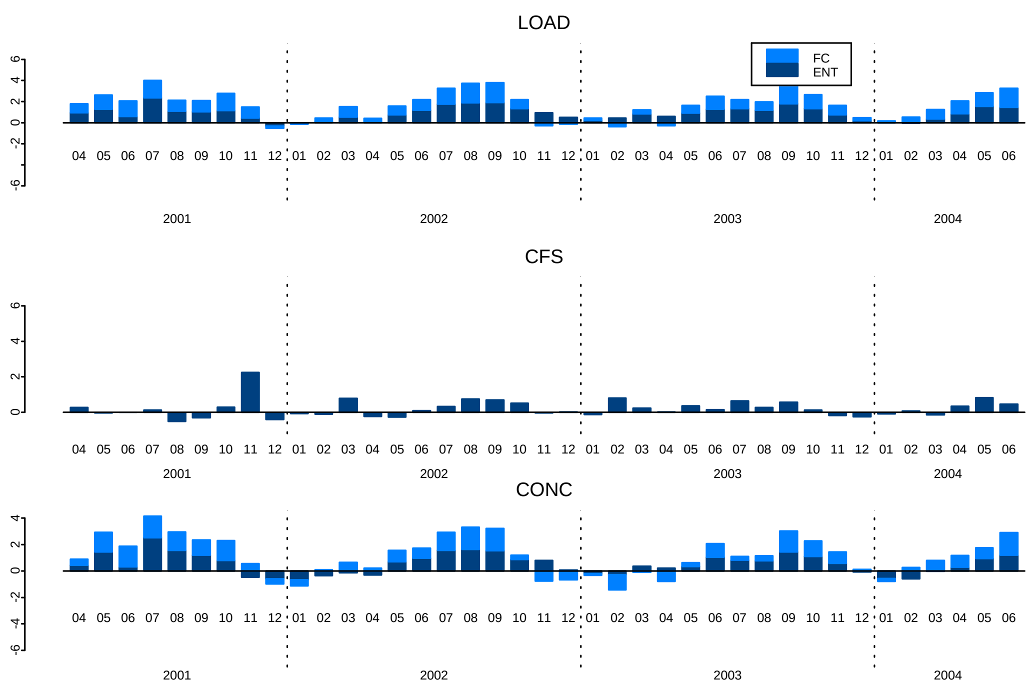
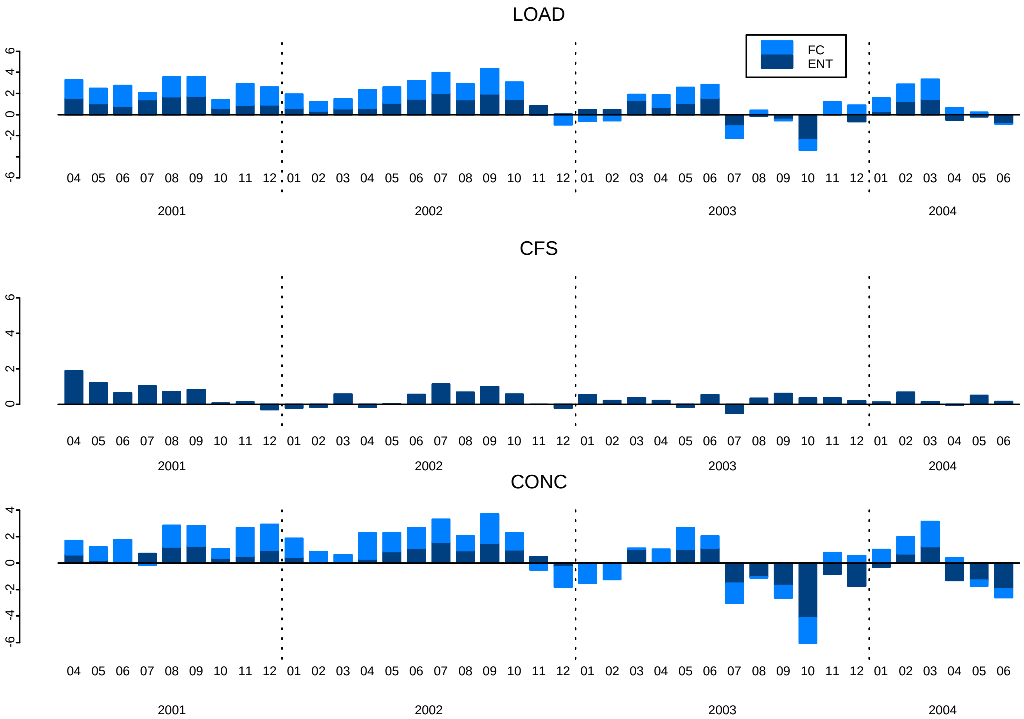


Figure B-7 (continued).

15. J01P28



16. J01P30

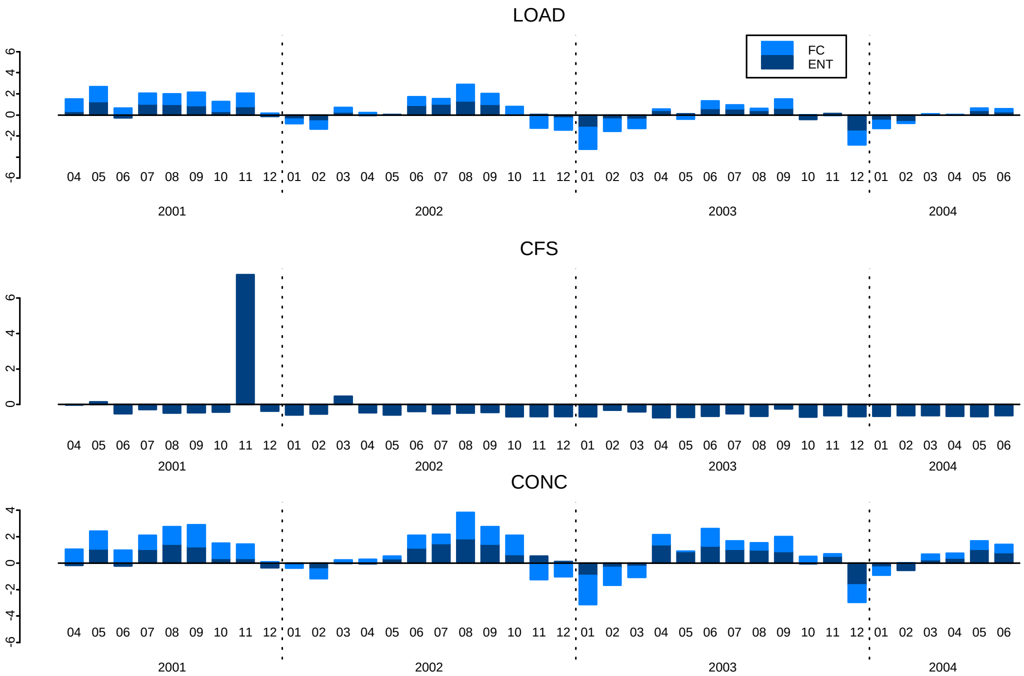
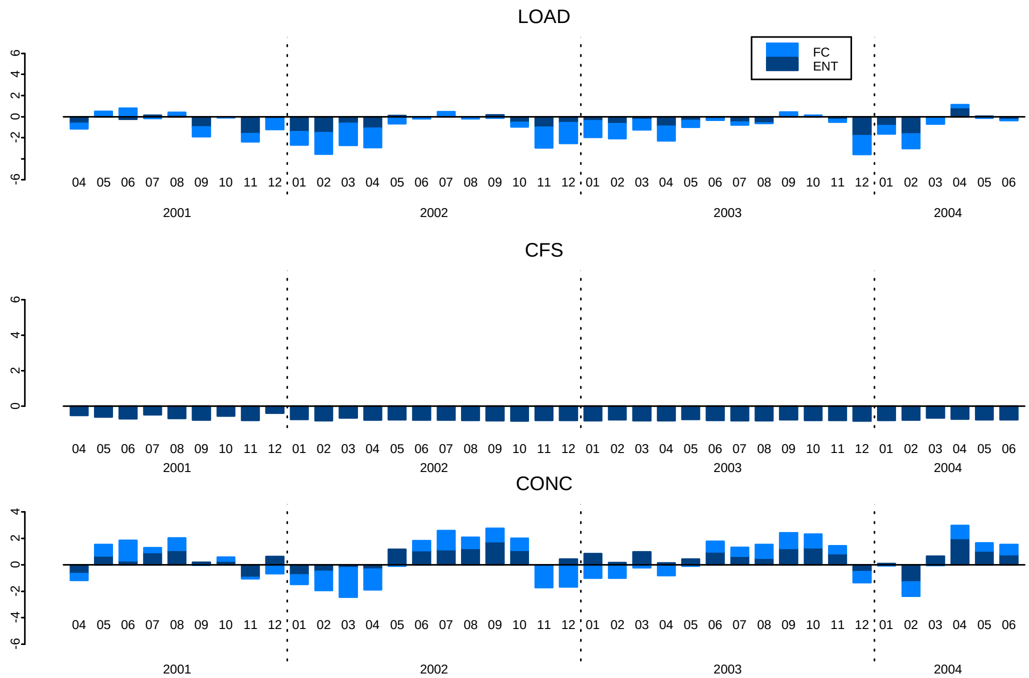


Figure B-7 (continued).

17. J01P33



18. J01TBN2

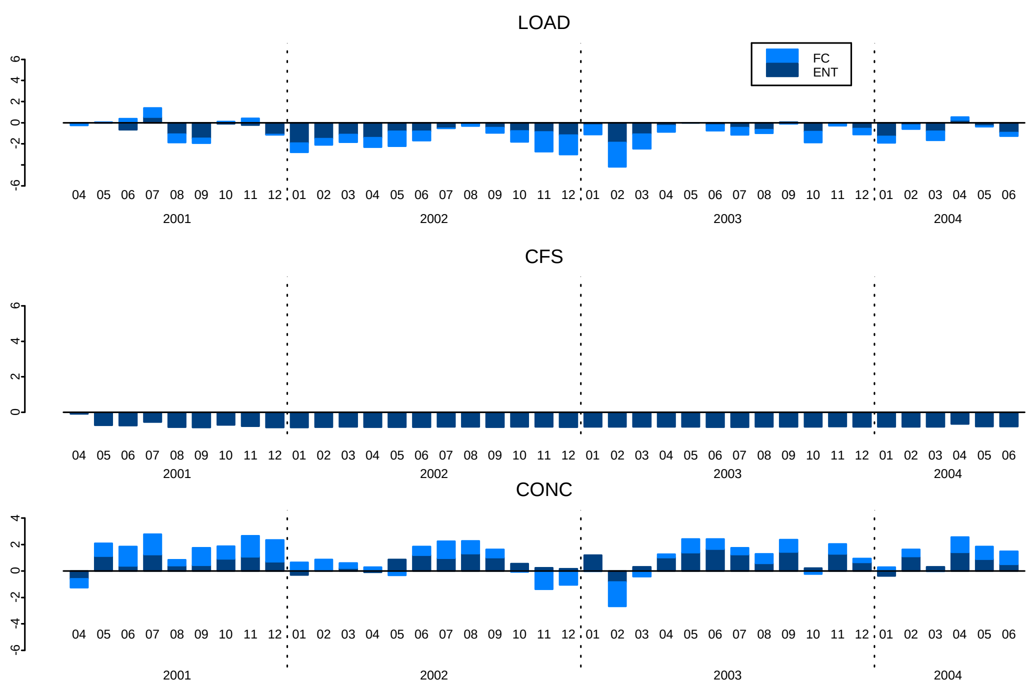
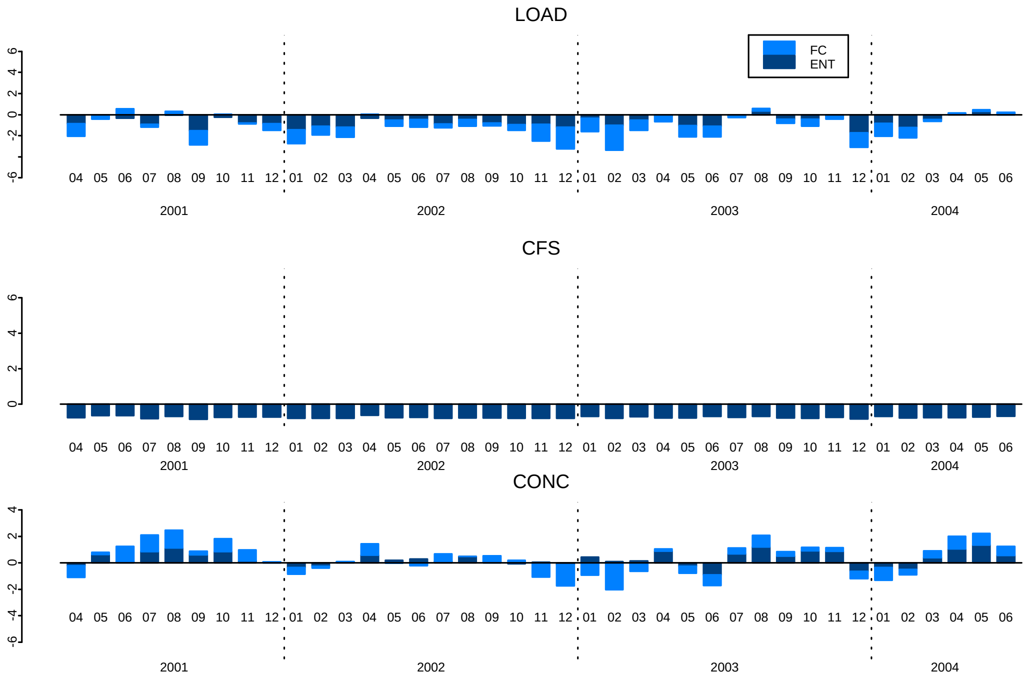


Figure B-7 (continued).

19. J01TBN3



20. J01TBN4

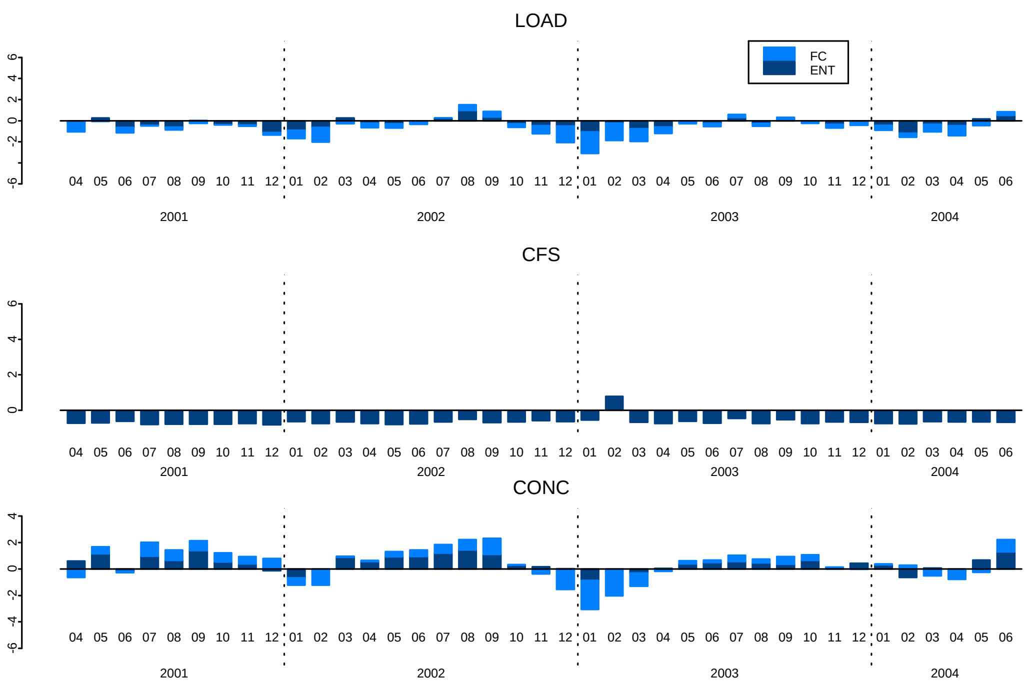
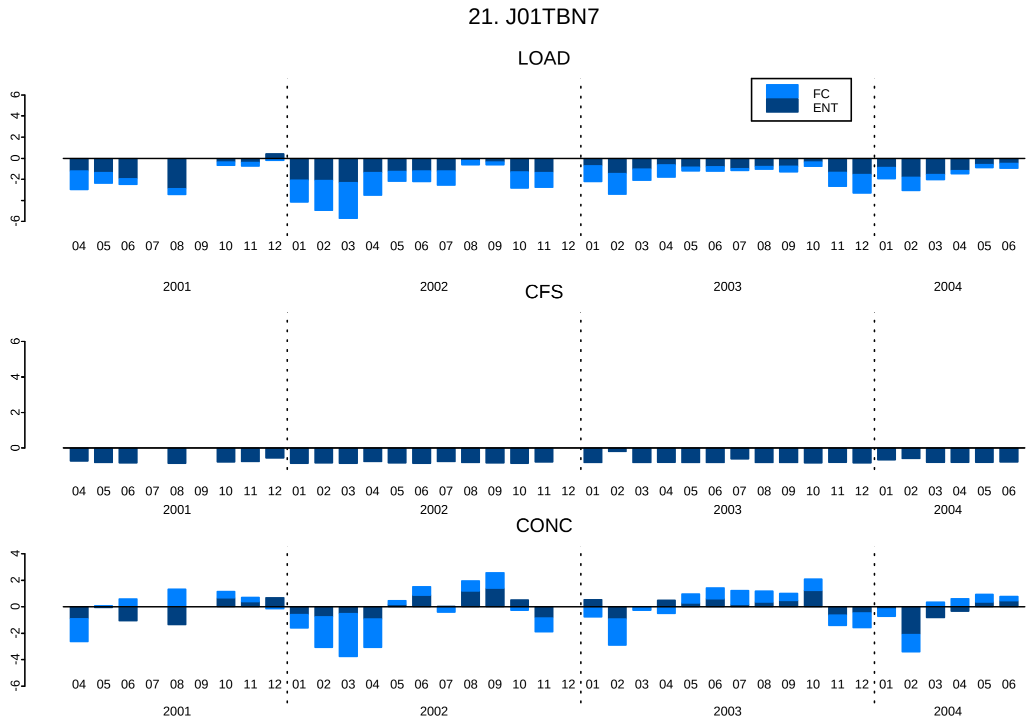


Figure B-7 (continued).



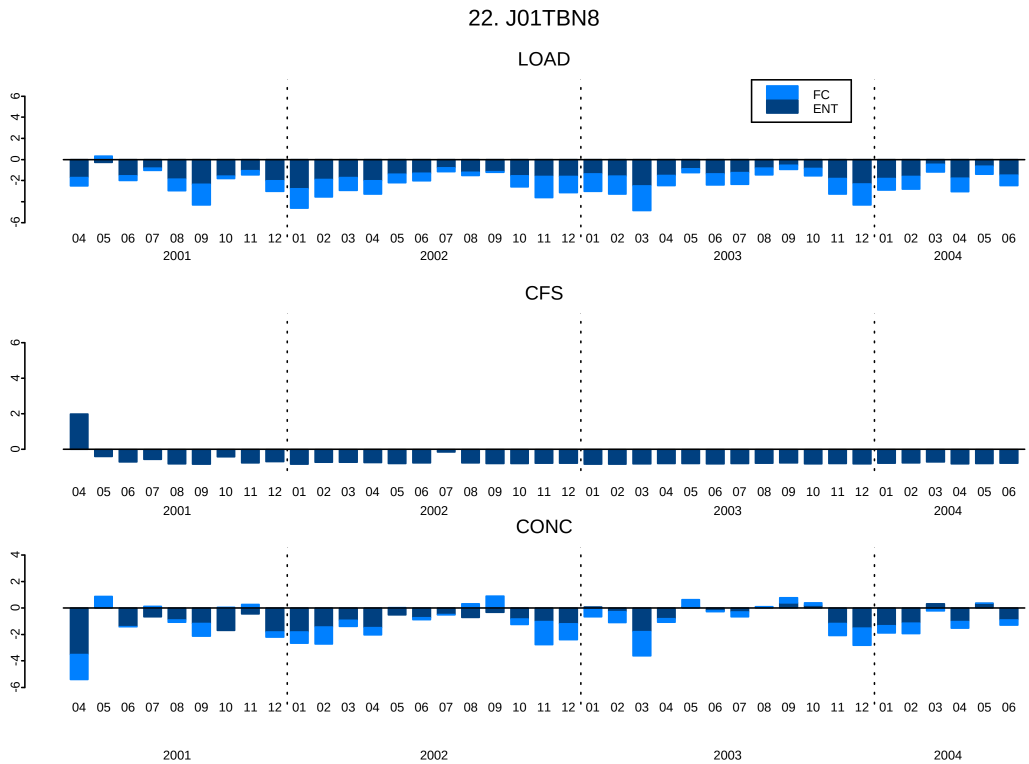
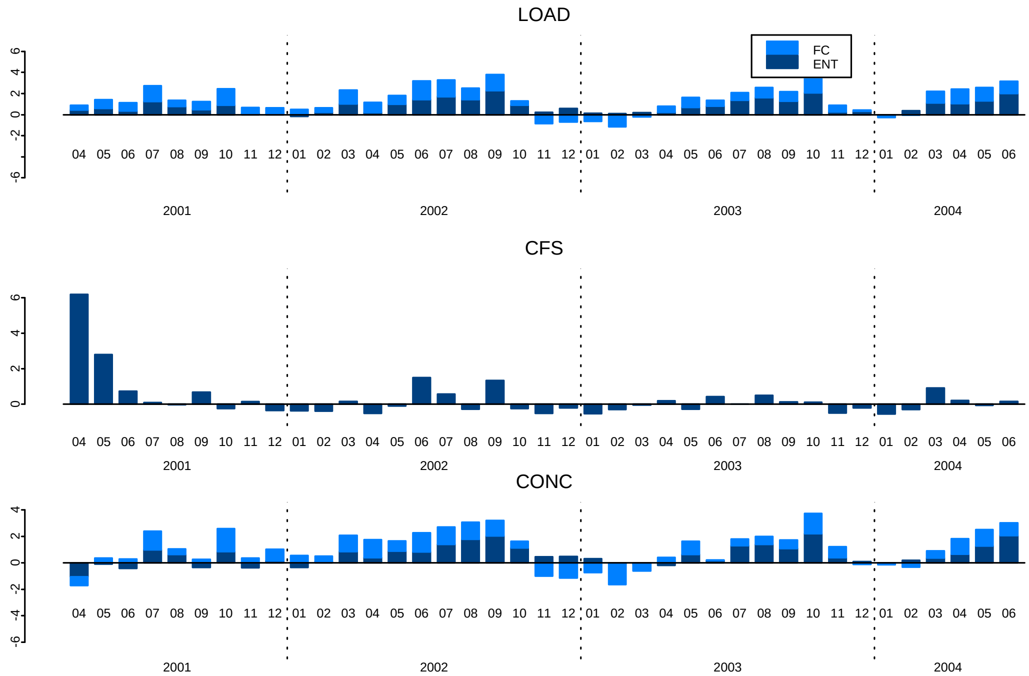


Figure B-7 (continued).

23. J02P05



24. J02P08

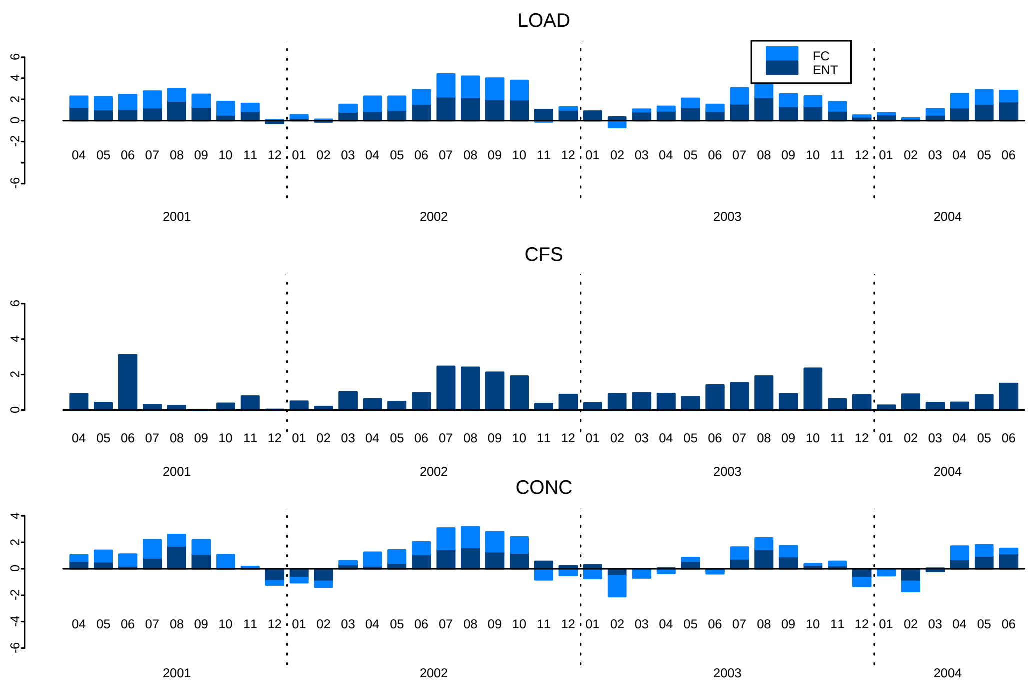
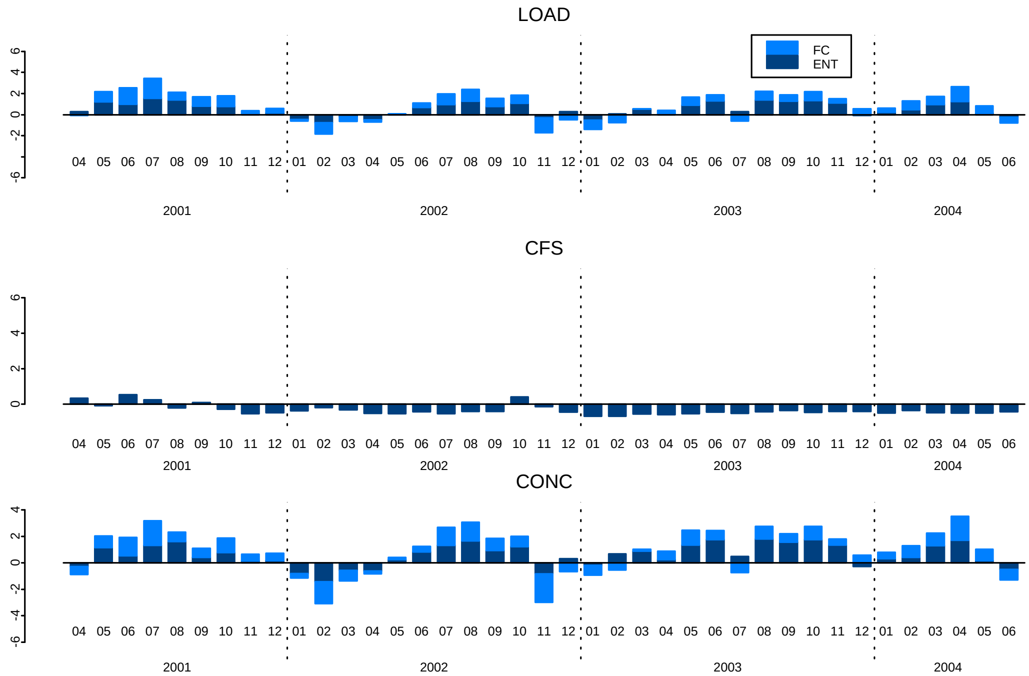


Figure B-7 (continued).

25. J02TBN1



26. J03P01

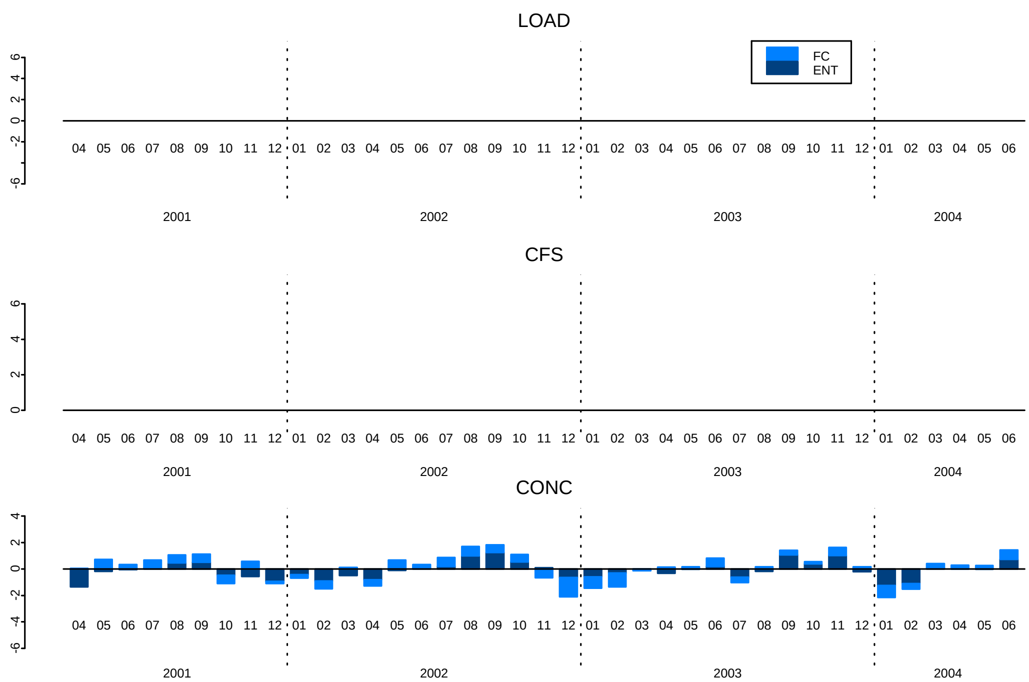
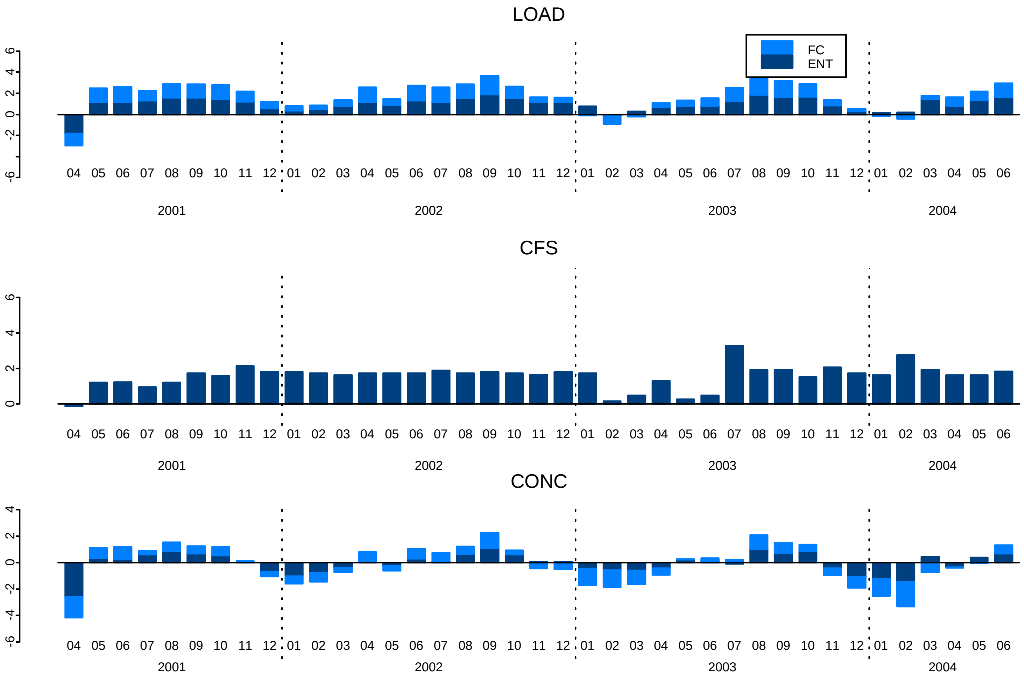


Figure B-7 (continued).

27. J03P02



28. J03P05

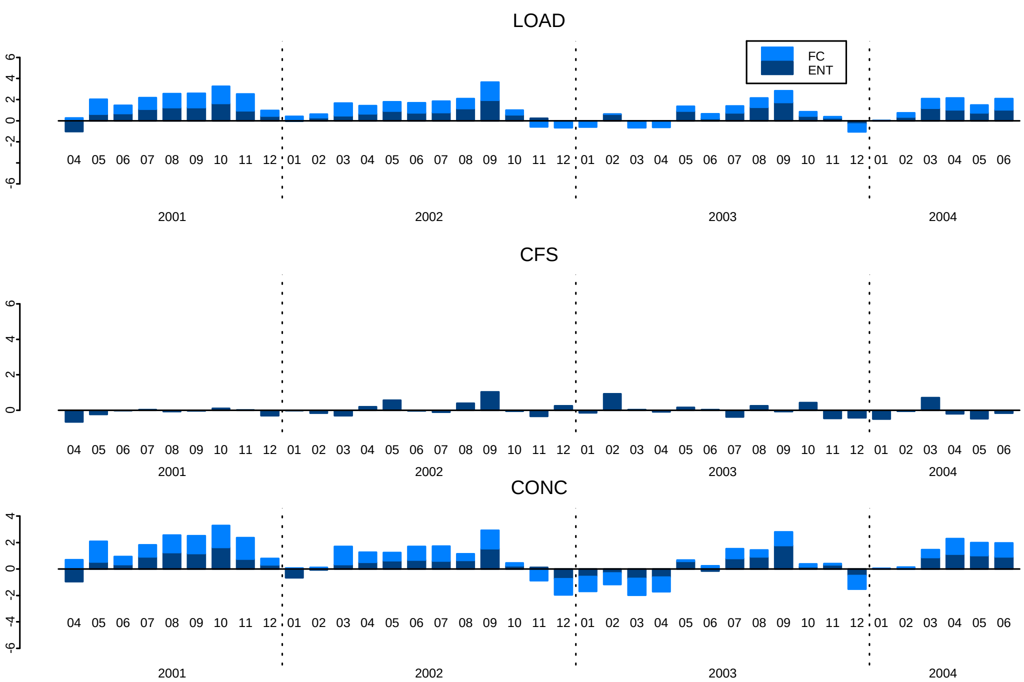
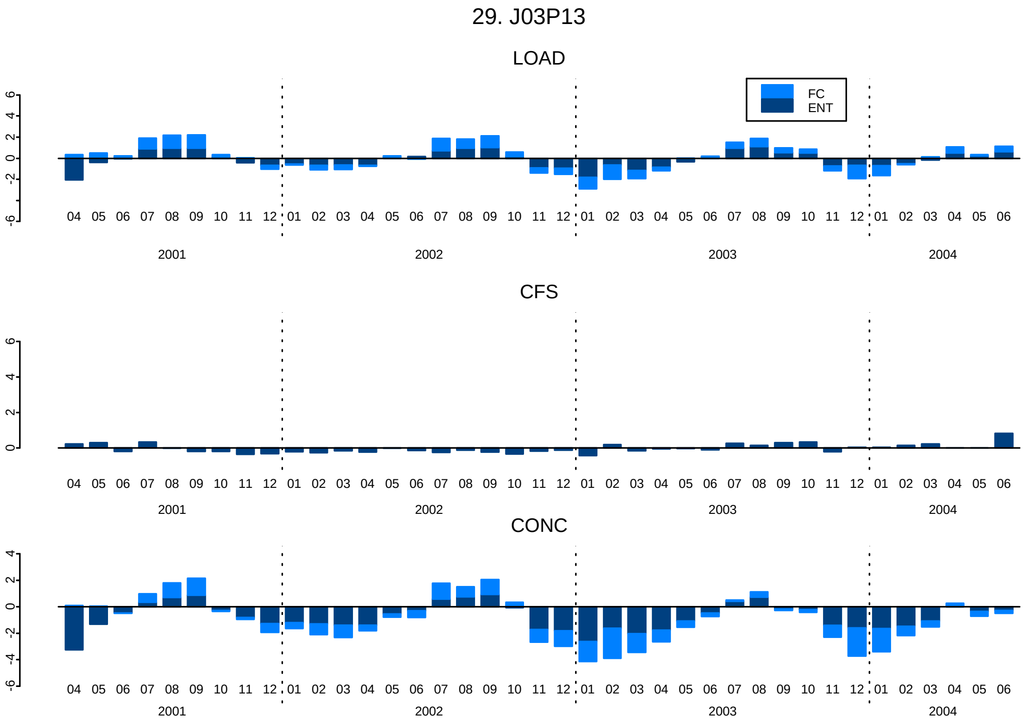


Figure B-7 (continued).



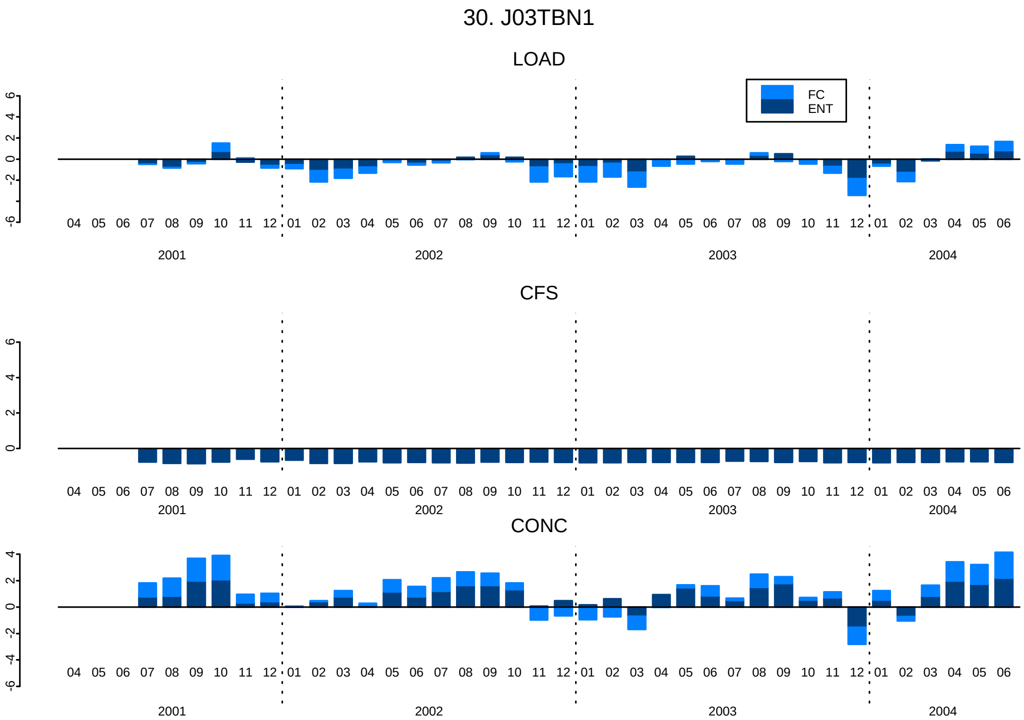
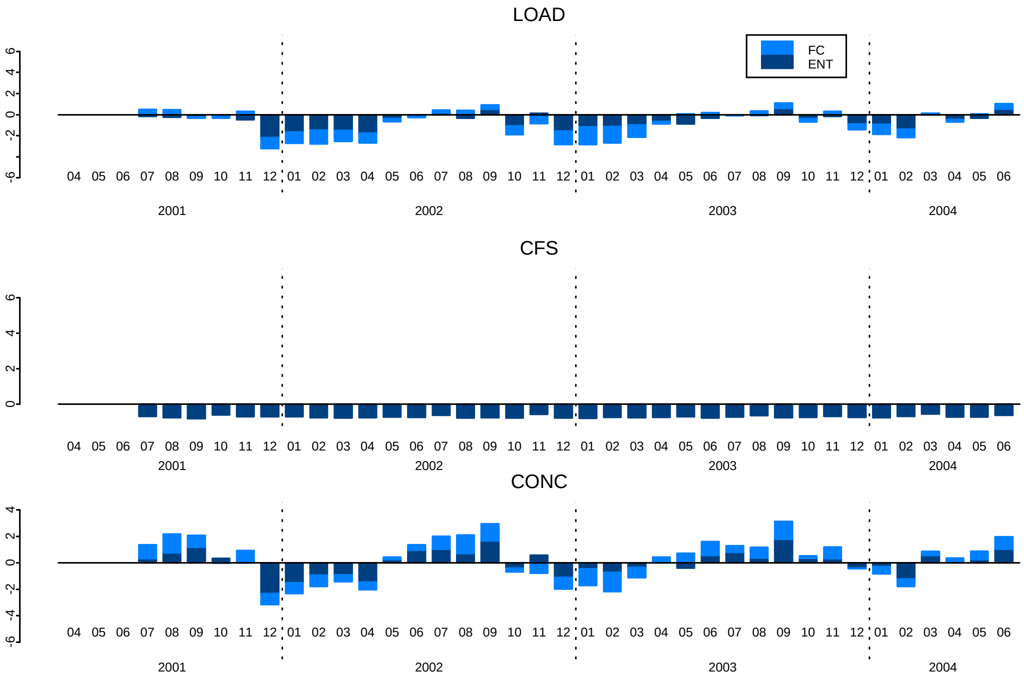


Figure B-7 (continued).

31. J03TBN2



32. J04

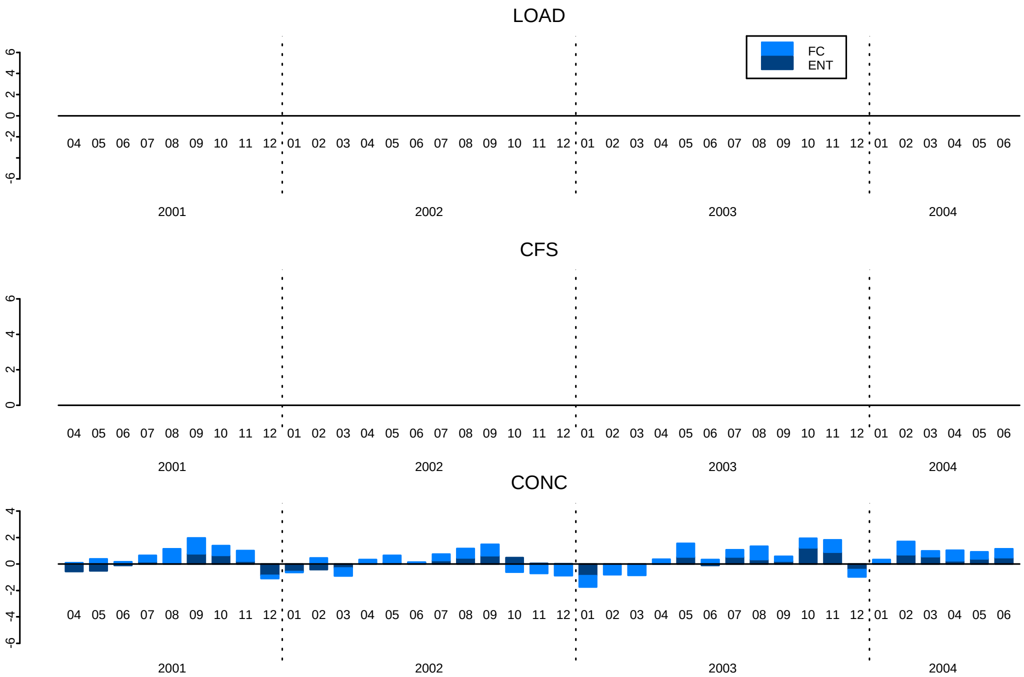
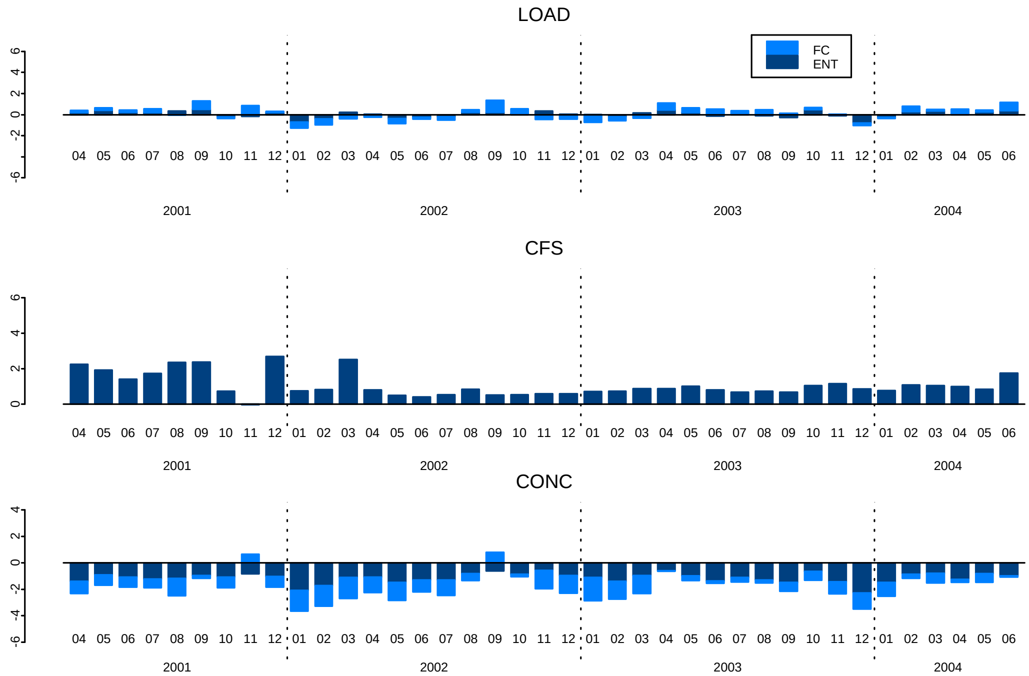


Figure B-7 (continued).

33. J05



34. J06

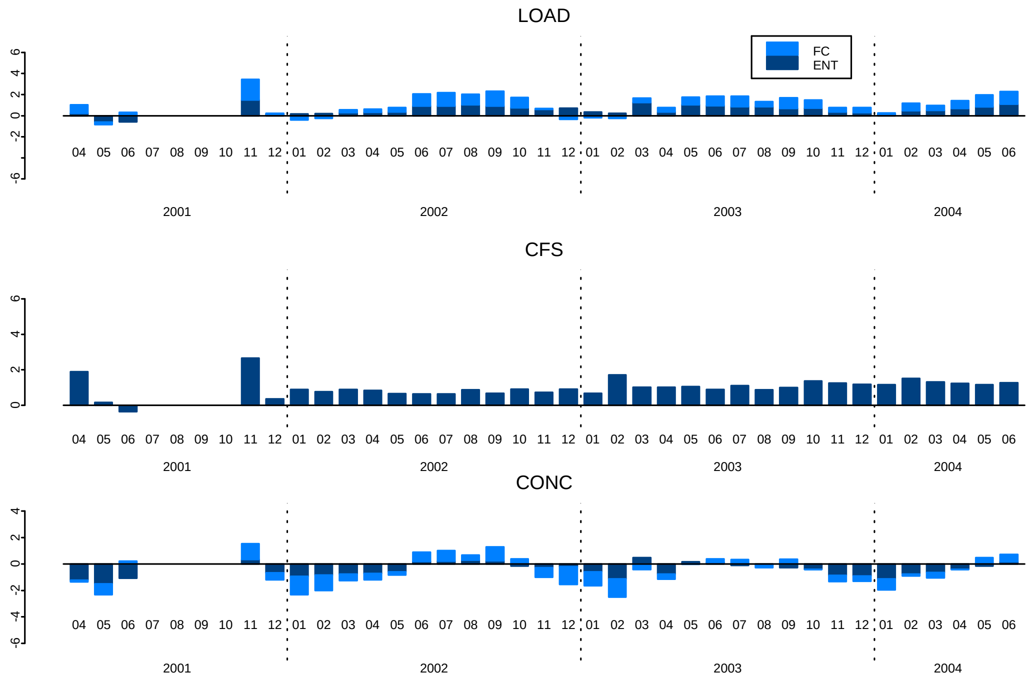
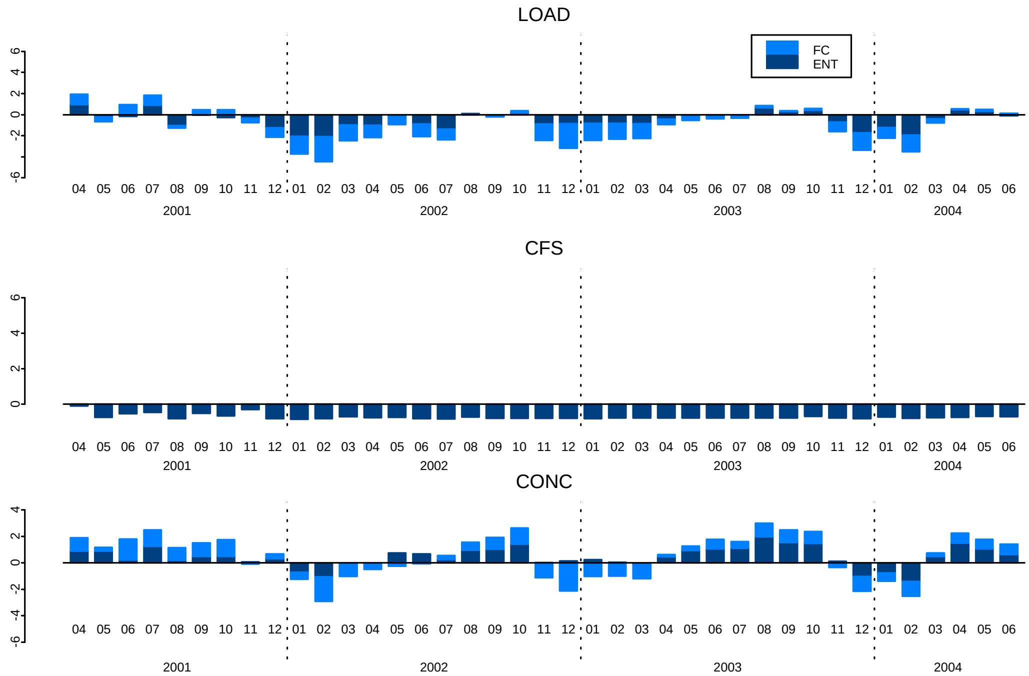


Figure B-7 (continued).

35. J07P01



36. J07P02

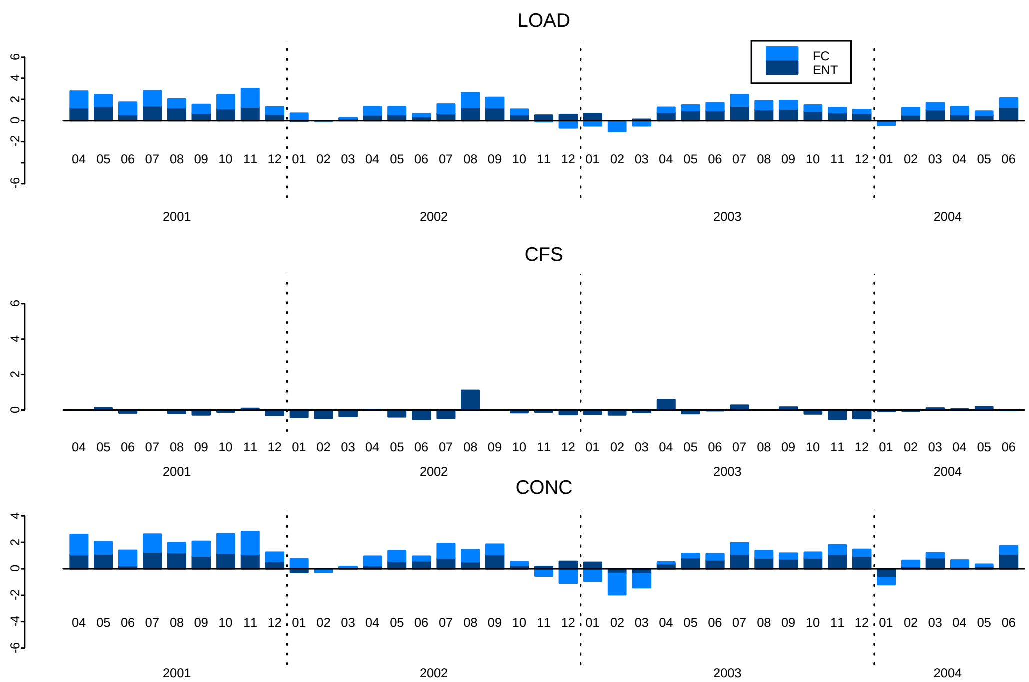


Figure B-8. Linear correlation between impact (difference between downstream and upstream concentrations) and load for Enterococcus at each pipe.

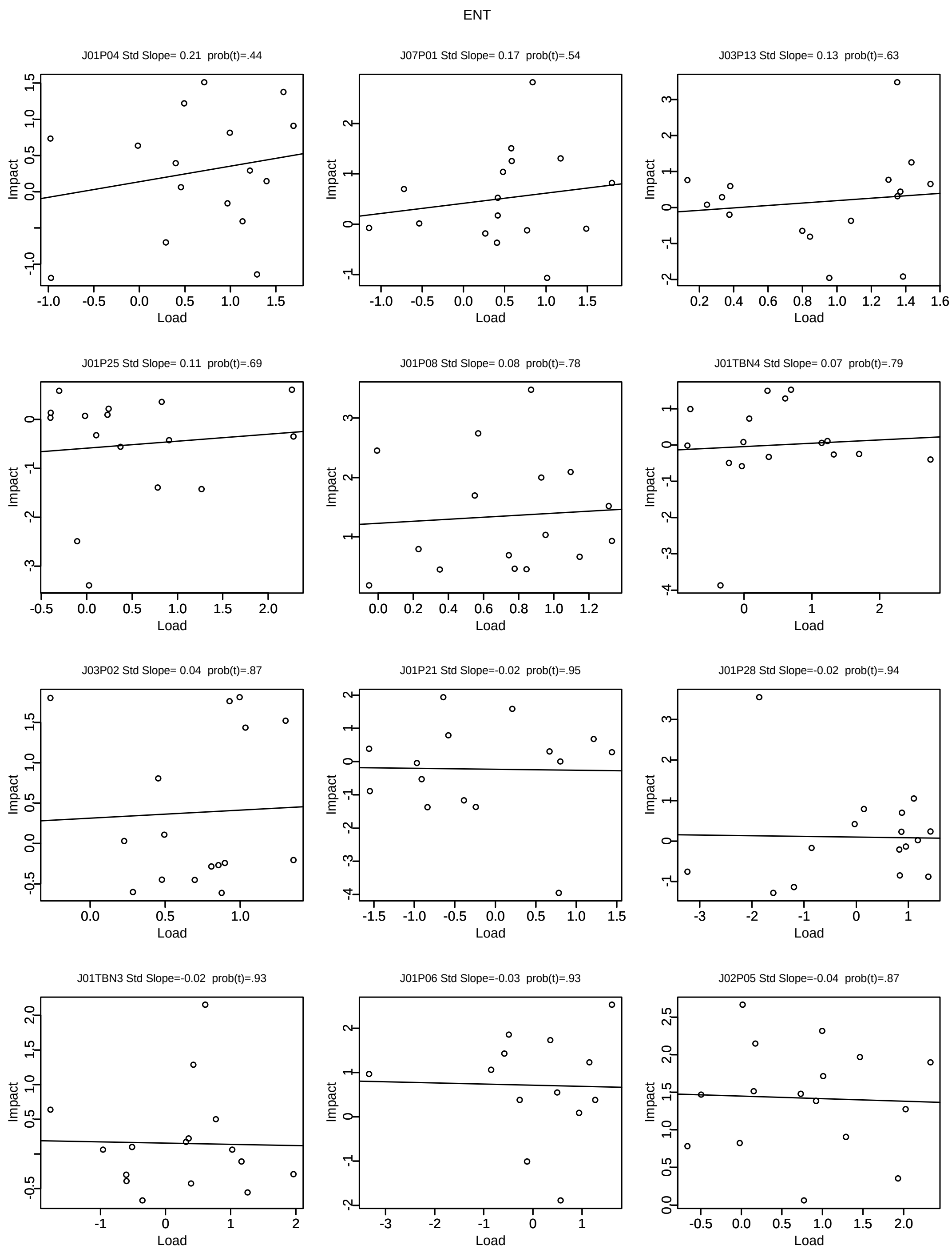


Figure B-8 (continued). Linear correlation between impact (difference between downstream and upstream concentrations) and load for Enterococcus at each pipe.

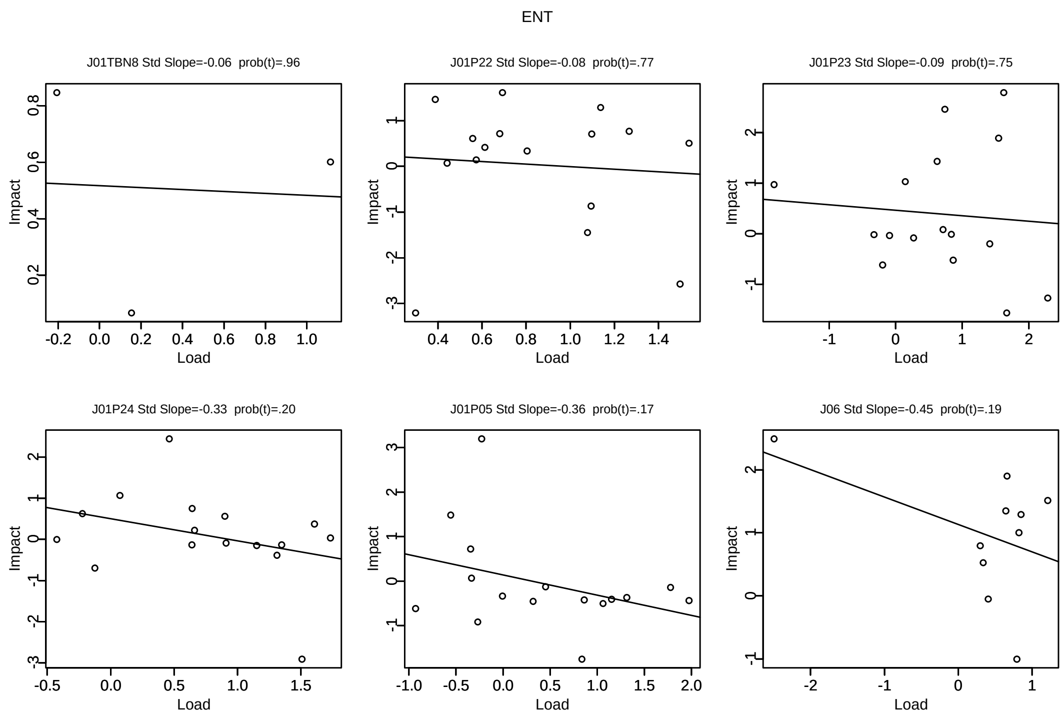


Figure B-9. Linear correlation between impact (difference between downstream and upstream concentrations) and load for fecal coliform at each pipe.

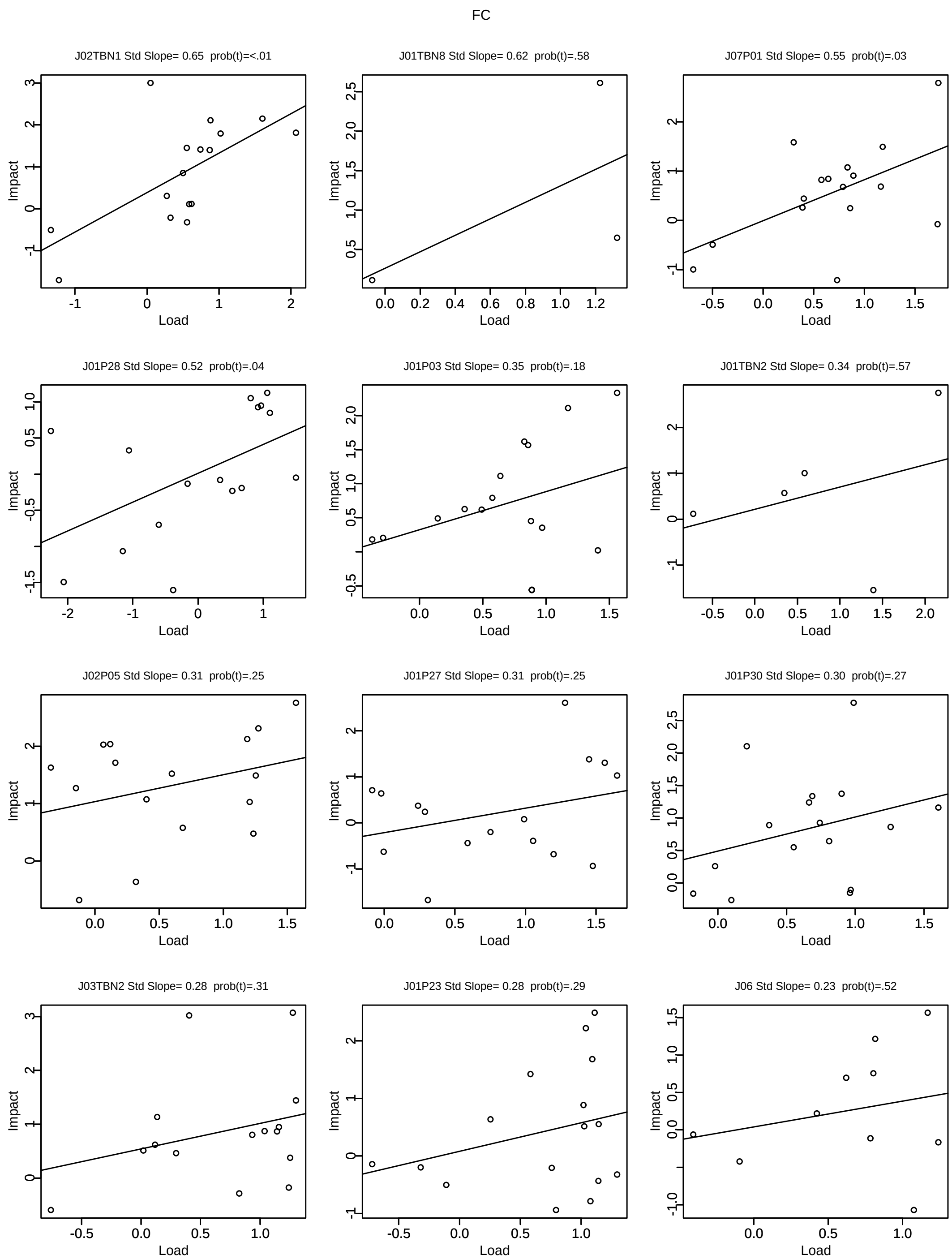


Figure B-9 (continued). Linear correlation between impact (difference between downstream and upstream concentrations) and load for fecal coliform at each pipe.

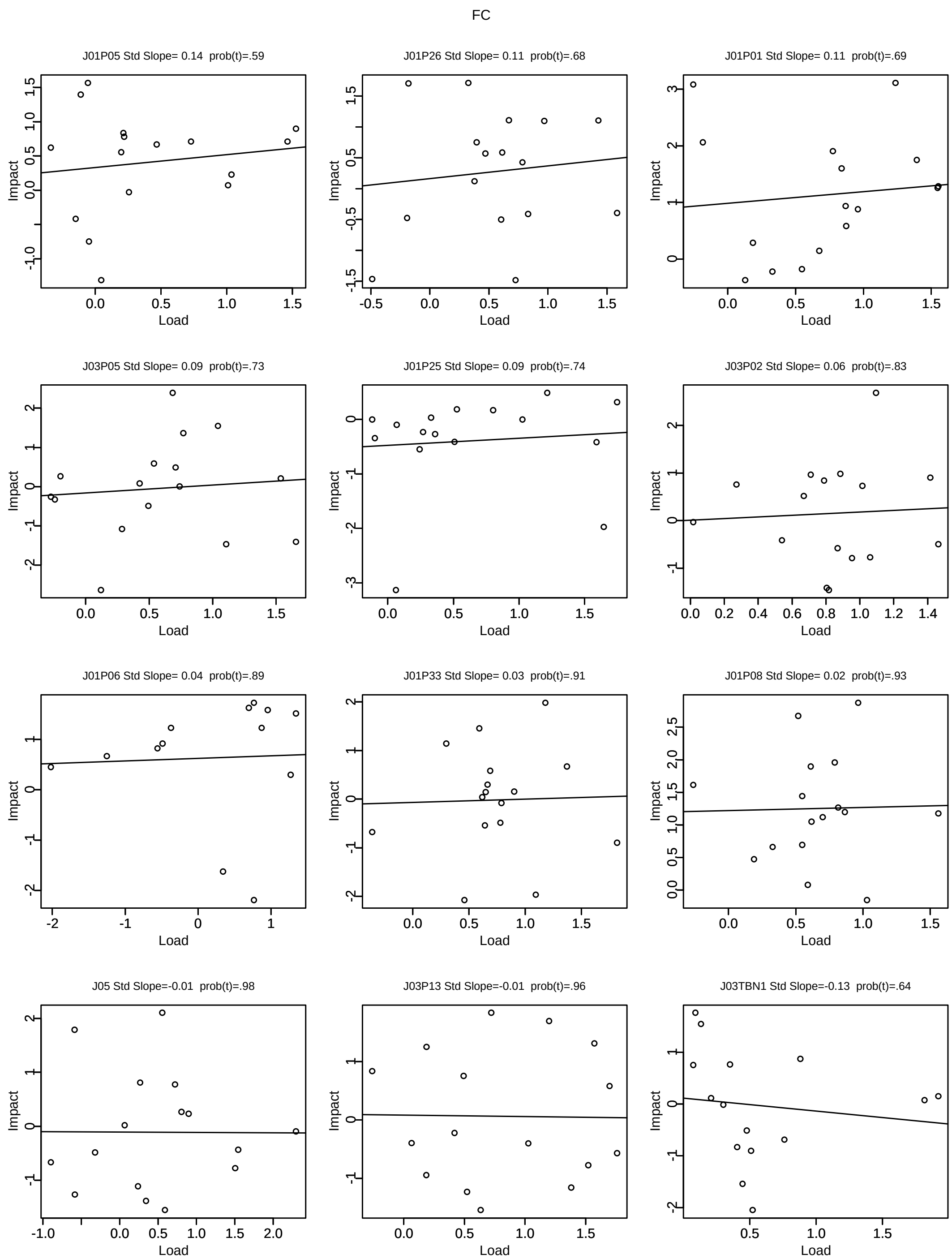


Figure B-9 (continued). Linear correlation between impact (difference between downstream and upstream concentrations) and load for fecal coliform at each pipe.